REMEDIAL ACTION CONTRACT

United States Environmental Protection Agency Region 6

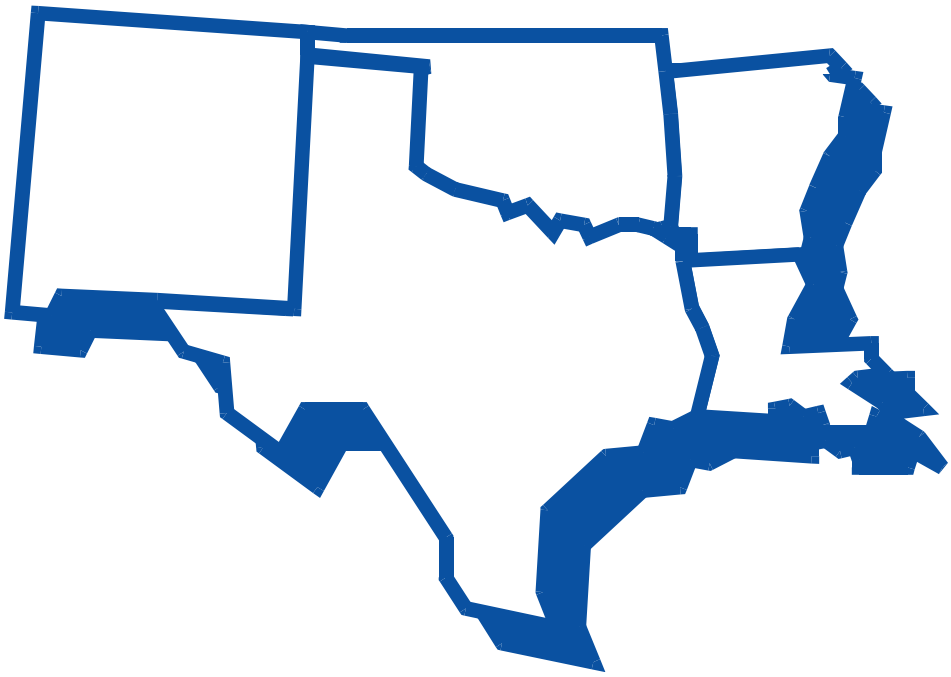
Contract No. EP-W-06-021

Human Health Risk Assessment
Version 1.1

Tar Creek Superfund Site Operable Unit 5
Ottawa County, Oklahoma

Task Order No. 079-RICO-06TS
Document Control No. 0079-02017

May 2020



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TASK ORDER NO. 079-RICO-06TS

Tar Creek Superfund Site Operable Unit 5
Ottawa County, Oklahoma

Human Health Risk Assessment
DCN: 0079-02017

Prepared for

U.S. Environmental Protection Agency

May 2020

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Human Health Risk Assessment
Operable Unit 5 Remedial Investigation
Tar Creek Superfund Site, Ottawa County, Oklahoma

Version	Date	Description
1.0	March 2020	This version represents the initial comprehensive submittal of the Human Health Risk Assessment report. This version has been prepared in consultation with the U.S. Environmental Protection Agency (EPA), with input from Tar Creek Superfund Site stakeholder representatives through conference calls, meetings, and interim deliverables.
1.1	May 2020	This version addresses EPA review comments on the initial submittal.

Note: As each new version is published, a description of the changes made will be included in this table.

Acknowledgements

EPA Region 6 and CH2M would like to express their appreciation to a number of organizations and individuals who contributed to the significant efforts of collecting existing site information and data that supported this project, and in the collection of new data. In particular, we would like to thank each American Indian Nation or Tribe within the region of the Tar Creek Superfund Site that helped us with this effort, including:

- Cherokee Nation
- Eastern Shawnee Tribe of Oklahoma
- Miami Tribe of Oklahoma
- Modoc Tribe of Oklahoma
- Ottawa Tribe of Oklahoma
- Peoria Tribe of Indians of Oklahoma
- Quapaw Nation
- Seneca-Cayuga Nation
- Wyandotte Nation

We would also like to thank the following federal, state, local, and other contributing stakeholders:

- Bureau of Indian Affairs
- Dr. F.E. Kirschner, LPG, LPHG, AESE, Inc.
- Dr. Robert Nairn, University of Oklahoma
- Ecological Specialists, Inc.
- Local Environmental Action Demanded Agency
- Paddlefish Research Center/Oklahoma Department of Wildlife Conservation
- The State of Kansas
- The State of Missouri
- The State of Oklahoma
- U. S. Environmental Protection Agency Region 7
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

Executive Summary

This Human Health Risk Assessment (HHRA) was prepared by CH2M HILL, Inc. (CH2M) for the U.S. Environmental Protection Agency (EPA) under EPA Region 6 Remedial Action Contract Number (No.) EP-W-06-021, Task Order 079-RICO-06TS. This HHRA report describes the methods, assumptions, and results of the HHRA performed for Operable Unit 5 (OU5) of the Tar Creek Superfund Site located in Ottawa County, Oklahoma (the site). The site is a former lead and zinc mining area consisting of the Oklahoma portion of the Tri-State Mining District (TSMD), which includes portions of southwestern Missouri, southeastern Kansas, and northeastern Oklahoma. The OU5 study area covers portions of seven watersheds that occur within the TSMD, and as such, extends from northeastern Oklahoma into southwestern Missouri and southeastern Kansas. The study area location is shown on Figure ES-1.

The purpose of the HHRA is to evaluate the potential risks associated with potential exposures to chemicals of potential concern (COPCs) by human receptors identified in the OU5 study area under current and reasonably foreseeable future land use conditions. This HHRA was conducted consistent with EPA Superfund HHRA and other supplemental guidance documents. In addition, input from site stakeholders was considered in the development of the conceptual exposure model and exposure assumptions for characterization of exposures to tribal members and citizens and the general public. EPA's Technical Review Workgroup for Metals and Asbestos Lead Committee was also consulted regarding the approach for lead evaluation for the OU5 study area.

This HHRA evaluates potential exposures to sediment, surface water, mine discharge, and aquatic biota at the site, and estimates potential risk for the following receptors:

- Tribal lifeway (adults and children)
- Aquatic workers (adults only)
- General public (adults and children)

Exposure scenarios evaluated for each exposure medium include the following:

- **Surface water/sediment (rivers and creeks).** Hunting/fishing/gathering and recreational activities (fishing and wading) (incidental ingestion and dermal contact) for tribal lifeway activities, work activities for aquatic workers (for example, hatchery or environmental employees), and recreational activities (swimming/wading/fishing/hunting) for the general public.
- **Surface water (rivers and creeks).** Potable use (ingestion and dermal contact) for tribal lifeway activities and general public recreational activities.
- **Surface water (rivers and creeks).** Use of surface water in a sweat lodge (ingestion, dermal contact, and inhalation of water vapors) as part of tribal lifeway activities.
- **Aquatic biota (fish, shellfish, aquatic plants, amphibians/aquatic reptiles, and semi-aquatic mammals).** Food consumption (ingestion) as part of tribal lifeway activities, food consumption (ingestion - fish only) by the general public, and medicinal use (dermal - aquatic plants only) as part of tribal lifeway activities.

In addition to the above, an evaluation of mine discharge was performed as part of the uncertainty analysis in this HHRA using the surface water scenario for both tribal lifeway and general public receptors. Mine discharge has been found to occur in a few locations in the OU5 watersheds; however, the potential for exposure to mine discharge is expected to be highly limited because of its intermittent occurrence, typical low flow rates, and relatively low accessibility.

Historical analytical metals data (data collected by various investigators and sampling programs before 2017), data obtained during the 2017 remedial investigation (to fill data gaps identified in the Data Gap Summary Report [CH2M, 2017]), and 2017 fish data provided by the Oklahoma Department of Environmental Quality (ODEQ) were combined and used in the HHRA. The combined data for the HHRA were grouped by watershed and exposure medium.

Using the data groupings identified for each watershed and exposure medium, potential exposures to COPCs were quantified based on exposure factors developed using EPA guidance documents, literature describing Native American exposure characteristics, and inputs from the Quapaw Nation and TCTCIT. For metals other than lead, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) specifies an acceptable site excess lifetime cancer risk (ELCR) range of one in a million to one in ten thousand (1×10^{-6} to 1×10^{-4}). Generally, remedial actions are not warranted for site media with an ELCR of 1×10^{-4} or a hazard index (HI) of 1 or less, although it may be warranted if other site-specific information suggests to risk managers that action is appropriate.

In addition, potential unacceptable risk associated with exposure to lead in environmental media within the OU5 study area was evaluated separately as the standard approach for the evaluation of lead (using biokinetic modeling) is different from other chemicals. Potential lead exposure was evaluated using the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children, Windows, Version 1.1, Build 11 (EPA, 2010) and the Adult Lead Methodology (ALM) (EPA, 2017a). The results of the IEUBK and ALM were expressed as follows:

- The IEUBK model results are expressed as the predicted geometric mean (GM) blood lead level (BLL) for children and the percentage of the child population with potential BLLs above the target BLL. Based on the EPA Office of Land and Emergency Management policy (EPA, 1994a), which strives to reduce lead exposure levels so there is no more than a 5 percent probability that children exposed to lead will exceed a BLL of 10 micrograms per deciliter (µg/dL), 10 µg/dL was used as a target BLL and two additional lower target BLLs (5 and 8 µg/dL) were used to provide additional information for comparison.
- The ALM model was used to calculate potential BLLs for the aquatic worker scenario. The model results are expressed as the predicted GM BLL, the corresponding 95th percentile fetal BLLs, and the probability that fetuses exposed to lead will exceed a BLL above the same set of target BLLs (5, 8, and 10 µg/dL) used in the IEUBK model.
- Children (and fetuses) are more sensitive to the effects of lead than adults. Consistent with the standard EPA approach, adult exposures to lead are not evaluated using the ALM when children are evaluated within the same receptor type (i.e., adult tribal lifeway and adult general public exposures to lead were not modeled since child exposures to lead were modeled for these receptor groups).

Based on the risk estimates and output from the lead models, preliminary chemicals of concern (COCs) were identified. Preliminary COCs are chemicals that drive risks based on the exceedance of EPA-acceptable ELCR and/or HI and the lead model output, without regard for background levels or relation to sources associated with historical site activities. The list of preliminary COCs was refined using two additional considerations to identify final COCs: (1) background comparisons, and (2) attribution to mine-related contamination. Final COCs are listed in Table ES-1; specific health endpoints associated with final COCs are summarized in Table ES-2.

The methodologies and assumptions used in an HHRA have inherent as well as site-specific uncertainties. Section 6.6 summarizes uncertainties and their effect on the estimate of potential health outcomes for site-specific scenarios that were of interest to tribal stakeholders. While it is theoretically possible that the HHRA leads to underestimates of potential health outcome, the use of numerous upper-bound assumptions in this HHRA most likely results in conservative estimates.

References

CH2M HILL, Inc. (CH2M). 2017. *Remedial Investigation Data Gap Summary Report, Version 1.1. Tar Creek Superfund Site Operable Unit 5, Remedial Investigation. Ottawa County, Oklahoma.* November.

U.S. Environmental Protection Agency (EPA). 1994a. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities.* Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-12.

U.S. Environmental Protection Agency (EPA). 2010. Integrated Exposure Uptake Biokinetic Model for Lead in Children, Windows, Version 1.1, Build 11. Available online: https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals. February.

U.S. Environmental Protection Agency (EPA). 2017a. Adult Lead Methodology (ALM) spreadsheet (MS Excel). Available: https://www.epa.gov/superfund/lead-superfund-sites-software-and-users-manuals#recommend

Table ES-1. Final COCs for Tar Creek OU5

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Final COCs	Sitewide (Biota Only)	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
Sediment							
Cadmium		TL	TL, AW		TL		
Lead		TL, AW, GP	TL, AW, GP		TL, GP		TL, GP
Zinc		TL	TL		TL		
Surface Water							
Antimony		TL					
Arsenic			TL, AW, GP				
Barium				TL			
Cadmium		TL, AW, GP	TL, GP		TL		
Cobalt			TL, AW, GP		TL		
Iron			TL, GP	TL			
Lead[a]		TL, GP	TL, GP		TL, GP		
Manganese			TL, AW, GP				
Nickel		TL	TL, AW		TL		
Zinc		TL	TL				
Biota[b]							
Barium	TL						
Cadmium	TL						
Copper	TL						
Lead	TL, GP						
Nickel	TL						
Silver	TL						
Zinc	TL						

Notes:

[a] Lead in surface water was not evaluated for aquatic workers because of the limitations of the ALM.

[b] Final COCs were identified based on sitewide dataset.

Final COCs are identified for the following receptors: TL = Tribal Lifeway, AW = Aquatic Worker, GP = General Public.

ALM = Adult Lead Methodology

COC = chemical of concern

HHRA = human health risk assessment

OU5 = Operable Unit 5

Table ES-2. Summary of Exceedances of EPA-Acceptable Risk by Receptors/Watersheds

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Receptor Scenario	Sitewide (Biota only)	Watershed					
		Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
Sediment							
Tribal Lifeway (Child) [a]		HI [b] (Cd, Zn) Lead [c]	HI [b] (Cd, Zn) Lead [c]	None	HI [b] (Cd, Zn) Lead [c]	None	Lead [c]
Aquatic Worker		Lead [c]	HI [b] (Cd) Lead [c]	None	None	None	None
General Public (Child) [a]		Lead [c]	Lead [c]	None	Lead [c]	None	Lead [c]
Surface Water							
Tribal Lifeway (Child) [a]		HI [b] (Sb, Cd, Ni, Zn) ELCR [d] (Cd, Ni) Lead [c]	HI [b] (As, Cd, Co, Fe, Mn, Ni, Zn) ELCR [d] (As, Cd, Co, Ni) Lead [c]	HI [b] (Ba, Fe)	HI [b] (Cd, Co, Ni) ELCR [d] (Cd, Co, Ni) Lead [c]	None	None
Aquatic Worker		HI [b] (Cd)	HI [b] (As, Co, Mn, Ni)	None	None	None	None
General Public (Child) [a]		HI [b] (Cd) Lead [c]	HI [b] (As, Cd, Co, Fe, Mn) ELCR [d] (As) Lead [c]	None	Lead [c]	None	None
Biota (Sitewide) [e]							
Tribal Lifeway (Child) [a]	HI [b, e] (Ba, Cd, Cu, Ni, Ag, Zn) Lead [c, e]						
General Public (Child) [a]	Lead [c, e]						

Notes:

[a] Conclusions for target organ HI are based on the results of child receptors because the child exposure scenario yields a higher non-carcinogenic HI than the adult exposure scenario, and child receptors are more sensitive to lead than adult receptors.

[b] Exceedance of EPA-acceptable target organ HI of 1.

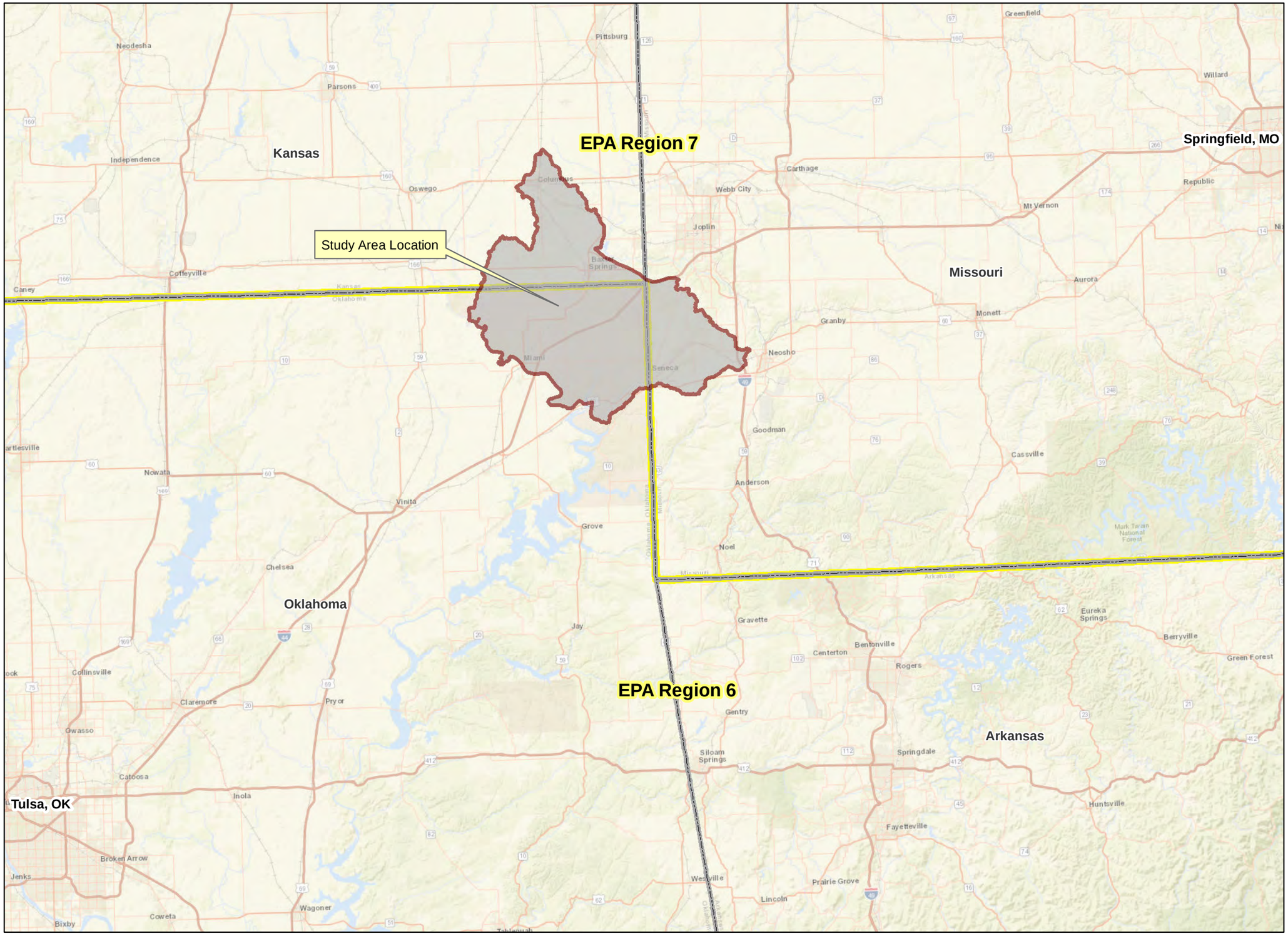
[c] Exceedance of target probability of BLL above 5 µg/dL.

[d] Exceedance of EPA-acceptable site ELCR range (1×10^{-6} to 1×10^{-4}).

[e] Biota risk estimates were based on sitewide data.

Chemicals exceeding EPA-acceptable risks are termed "Preliminary Chemicals of Concern" without consideration of background levels or attribution to mining wastes. Background comparison and the nature of mining-related contamination were used to refine the list of preliminary COCs to identify final COCs. Final COCs that exceed EPA-acceptable risk levels are summarized in this table.

µg/dL = microgram(s) per deciliter
BLL = blood lead level
COC = chemical of concern
ELCR = excess lifetime cancer risk
HHRA = human health risk assessment
HI = hazard index
Ag = silver
Ba = barium
Cd = cadmium
Co = cobalt
Cu = copper
Fe = iron
Ni = nickel
Sb = antimony
Zn = zinc



Legend

- Study Area Location
- State Boundary
- EPA Region Boundary

Notes:
1. Imagery Source: ESRI World Street Map online mapping service
2. Operable Unit 5 does not have specific boundaries, but is defined by the extent of the watersheds that have been identified by EPA as relevant to the superfund site.

EPA = Environmental Protection Agency

N

0 11 22 Miles

Figure ES-1.
Study Area Location Map
Tar Creek Superfund Site
Operable Unit 5 HHRA
Ottawa County, Oklahoma

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Contents

Section Page

Executive Summary **ES-1**

Acronyms and Abbreviations ..... **v**

1 Introduction **1-1**
1.1 Purpose and Overview 1-1
1.2 Report Organization 1-3

2 Site Characteristics and Potential Receptors **2-1**
2.1 Site Description 2-1
2.2 Site History 2-1
2.3 Demographics 2-2
2.4 Land Use and Designated Beneficial Use of Water within the OU5 Study Area 2-2
2.5 Conceptual Exposure Model 2-2

3 Data Evaluation **3-1**
3.1 Data Used in the Human Health Risk Assessment 3-1
3.1.1 Sediment 3-1
3.1.2 Surface Water 3-2
3.1.3 Mine Discharge 3-3
3.1.4 Aquatic Biota 3-3
3.2 Identification of Chemicals of Potential Concern 3-9
3.2.1 COPC Selection for Tribal Lifeway and Aquatic Workers 3-9
3.2.2 COPC Screening Levels for General Public 3-9
3.2.3 Chemicals Excluded as COPCs 3-9
3.2.4 COPC Screening Results 3-10
3.2.5 Background Comparison 3-10

4 Exposure Assessment **4-1**
4.1 Human Health Conceptual Exposure Model 4-1
4.1.1 Identification of Potential Receptors 4-1
4.2 Exposure Pathways Quantified 4-2
4.3 Quantification of Exposure 4-2
4.3.1 Exposure Point Concentrations 4-2
4.3.2 Exposure Factors 4-2
4.3.3 Intake Estimate 4-6
4.3.4 Approach for Mutagenic Exposures 4-9
4.3.5 Approach for Arsenic Speciation 4-9

5 Toxicity Assessment **5-1**
5.1 Non-carcinogenic Toxicity Values 5-1
5.1.1 Cadmium 5-1
5.1.2 Chromium 5-1
5.1.3 Manganese 5-2
5.1.4 Mercury 5-2
5.1.5 Phosphorus 5-2
5.1.6 Vanadium 5-2
5.1.7 Silica 5-2

Section Page

5.1.8 Thallium 5-3
5.2 Carcinogenic Toxicity Values 5-3
5.2.1 Chromium 5-3
5.3 Derivation of Dermal Toxicity Values 5-3

6 Risk Characterization 6-1
6.1 Approach for Potential Non-carcinogenic Effects 6-1
6.2 Approach for Potential Carcinogenic Effects 6-2
6.3 Approach for Lead 6-3
6.4 Summary of Risk Estimates 6-3
6.5 Chemicals of Concern 6-4
6.5.1 Identification of Preliminary COCs 6-4
6.5.2 Refinement of Preliminary COCs 6-4
6.6 Uncertainty Analysis 6-5
6.6.1 General Uncertainties 6-5
6.6.2 Uncertainties Associated with OU5 Study Area-Specific Data and Data Usage . 6-6

7 References 7-1

Appendixes

A Response to Comments on Interim HHRA Deliverables
B Risk Assessment Guidance for Superfund (RAGS) Part D Tables
C Data Grouping and Sample Lists
D ProUCL Output
E Analysis of Lead Exposure
F Uncertainty Analysis

Tables

2-1 Demographic Data for the Counties within the TSMD and State of Oklahoma
2-2 Watershed-Specific Land Use Descriptions and Designated Beneficial Water Uses
3-1 Data Groupings and Associated Receptor/Exposure Scenarios
3-2 Summary of Chemicals of Potential Concern
6-1 Summary of Receptor Hazards and Selection of Preliminary Chemicals of Concern - Tribal Lifeway Child
6-2 Summary of Receptor Excess Lifetime Cancer Risks and Selection of Preliminary Chemicals of Concern - Tribal Lifeway Adult/Child Aggregate
6-3 Summary of Receptor Hazards and Excess Lifetime Cancer Risks and Selection of Preliminary Chemicals of Concern - Aquatic Worker
6-4 Summary of Receptor Hazards and Selection of Preliminary Chemicals of Concern - General Public Child
6-5 Summary of Receptor Excess Lifetime Cancer Risks and Selection of Preliminary Chemicals of Concern - General Public Adult/Child Aggregate
6-6 Final Sediment COCs for Tar Creek OU5 (Tribal Lifeway - Sediment)
6-7 Final Sediment COCs for Tar Creek OU5 (Aquatic Worker - Sediment)
6-8 Final COCs for Tar Creek OU5 (General Public - Sediment)
6-9 Final Surface Water COCs for Tar Creek OU5 (Tribal Lifeway - Surface Water)
6-10 Final Surface Water COCs for Tar Creek OU5 (Aquatic Worker - Surface Water)

6-11 Final Surface Water COCs for Tar Creek OU5 (General Public - Surface Water)
6-12 Final Biota COCs for Tar Creek OU5 (Tribal Lifeway - Biota)
6-13 Final Fish COCs for Tar Creek OU5 (General Public - Fish)
6-14 Final COCs for Tar Creek OU5
6-15 Summary of Receptor Hazards for Final COC - Tribal Lifeway Child
6-16 Summary of Receptor Risks for Final COC - Tribal Lifeway Adult/Child Aggregate
6-17 Summary of Receptor Hazards and Risks for Final COC - Aquatic Worker
6-18 Summary of Receptor Hazards for Final COC - General Public Child
6-19 Summary of Receptor Risks for Final COC - General Public Adult/Child Aggregate
6-20 General Uncertainties in the Human Health Risk Assessment

Figures

1-1 Study Area Location Map
2-1 Operable Unit 5 Watersheds
2-2 Tri-State Mining District Map
2-3 Conceptual Exposure Model
6-1 Decision Process for Identification of Final HHRA COCs

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Acronyms and Abbreviations

µg/dL	microgram(s) per deciliter
µg/m^3	microgram(s) per cubic meter
µm	micrometer(s)
ADAF	age-dependent adjustment factor
ALM	Adult Lead Methodology
ATSDR	Agency for Toxic Substances and Disease Registry
bss	below sediment surface
BLL	blood lead level
BTV	background threshold value
Cal/EPA	California Environmental Protection Agency
CEM	conceptual exposure model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH2M	CH2M HILL, Inc., now part of Jacobs Engineering Group Inc.
cm^2	square centimeter(s)
COC	chemical of concern
COPC	chemical of potential concern
Cr (III)	trivalent chromium
Cr (VI)	hexavalent chromium
CSF	cancer slope factor
CSM	conceptual site model
days/year	days per year
DCN	Document Control Number
DI	daily intake
EC	exposure concentration
EFH	Exposure Factors Handbook
ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FS	feasibility study
FWS	U.S. Fish and Wildlife Service
g	gram(s)
g/day	gram(s) per day
GM	geometric mean

HHEM	Human Health Evaluation Manual
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
kg	kilogram(s)
L water/m^3	liter(s) of water per cubic meter
MESL	MacDonald Environmental Sciences, Limited
mg	milligram(s)
mg/cm^2	milligram(s) per square centimeter per event
mg/kg	milligram(s) per kilogram
mg/kg-day	milligram(s) per kilogram per day
mg/L	milligram(s) per liter
mg/m^3	milligram(s) per cubic meter
MMOA	mutagenic mode of action
mol	mole
No.	number
NRCS	Natural Resources Conservation Service
ODEQ	Oklahoma Department of Environmental Quality
ODWC	Oklahoma Department of Wildlife Conservation
OLEM	Office of Land and Emergency Management
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
OU5	Operable Unit 5
pH	potential of hydrogen
PPRTV	Provisional Peer-Reviewed Toxicity Value
RAGS	Risk Assessment Guidance for Superfund
RI	remedial investigation
RI report	*Remedial Investigation Report, Tar Creek Superfund Site Operable Unit 5, Ottawa County, Oklahoma, Task Order No. 079-RICO-06TS* (CH2M, 2020)
RfC	reference concentration
RfD	reference dose
RSL	Regional Screening Level

S-B EWMP	Shoshone-Bannock Tribes Environmental Waste Management Program
TEMS	Tribal Environmental Management Services, LLC
TSMD	Tri-State Mining District
U.S.	United States
UCL	upper confidence limit
USDA	U.S. Department of Agriculture

SECTION 1

Introduction

This Human Health Risk Assessment (HHRA) was prepared by CH2M HILL, Inc. (CH2M)[1] for the U.S. Environmental Protection Agency (EPA) under EPA Region 6 Remedial Action Contract Number (No.) EP-W-06-021, Task Order 079-RICO-06TS. This HHRA report describes the methods, assumptions, and results of the HHRA performed for Operable Unit 5 (OU5) of the Tar Creek Superfund Site located in Ottawa County, Oklahoma (the site). The site is a former lead and zinc mining area consisting of the Oklahoma portion of the Tri-State Mining District (TSMD), which includes portions of southwestern Missouri, southeastern Kansas, and northeastern Oklahoma. The OU5 study area covers the watersheds that occur within the TSMD and, as such, extends from northeastern Oklahoma into southwestern Missouri and southeastern Kansas. The study area location is shown on Figure 1-1.

This HHRA supports the remedial investigation (RI) conducted for the Tar Creek Superfund Site and serves as a companion report to the *Remedial Investigation Report, Tar Creek Superfund Site Operable Unit 5, Ottawa County, Oklahoma, Task Order No. 079-RICO-06TS*, which is submitted under separate cover (CH2M, 2020; "the RI report"). Data presented in the RI report are used in this HHRA and referenced herein where needed for background and supporting information.

1.1 Purpose and Overview

This report presents the HHRA for potential exposure to sediment, surface water, mine discharge, and aquatic biota. The purpose of the HHRA is to evaluate the potential risks associated with potential exposures by current and future receptors to chemicals at the site.

The HHRA was conducted in accordance with EPA HHRA guidance. The following are the primary guidance documents used to prepare this HHRA:

- Risk Assessment Guidance for Superfund (RAGS). Volume I, Human Health Evaluation Manual (HHEM) (Part A) (EPA, 1989)
- RAGS. Volume I, HHEM (Part B, Development of Risk-based Preliminary Remediation Goals) (EPA, 1991)
- RAGS. Volume I, HHEM (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments) (EPA, 2001)
- RAGS. Volume I, HHEM (Part E, Supplemental Guidance for Dermal Risk Assessment (EPA, 2004)
- RAGS. Volume I, HHEM (Part F, Supplemental Guidance for Inhalation Risk Assessment) (EPA, 2009a)
- Guidance for Risk Characterization (EPA, 1995)
- Guidelines for Carcinogen Risk Assessment (EPA, 2005a)
- Framework for Metals Risk Assessment (EPA, 2007a)
- Exposure Factors Handbook (EFH), 2011 Edition with updates (EPA, 2011)
- HHEM, Supplemental Guidance: Update of Standard Default Exposure Factors (EPA, 2014)

[1] CH2M HILL (CH2M) was acquired by Jacobs Engineering Group Inc. (Jacobs) on December 15, 2017. CH2M is now a wholly owned direct subsidiary of Jacobs.

Additionally, the following lead-specific EPA guidance documents and directives were used in the analysis of lead exposure (Appendix E):

- Office of Solid Waste and Emergency Response (OSWER) Directive: Revised Interim Soil Lead Guidance for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sites and Resource Conservation and Recovery Act (RCRA) Corrective Action Facilities (EPA, 1994a)
- Guidance Manual for the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (EPA, 1994b)
- User's Guide for the IEUBK Model for Lead in Children, Windows (EPA, 2007b)
- Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil (EPA, 2003a)
- Assessing Intermittent or Variable Exposures at Lead Sites (EPA, 2003b)
- IEUBK Model for Lead in Children (EPA, 2010)
- Office of Land and Emergency Management (OLEM) Directive 9200.2-167. Memorandum: Updated Scientific Considerations for Lead in Soil Cleanups (EPA, 2016a)
- OLEM Directive 9285.6-56. Memorandum: Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters (EPA, 2017b)
- OLEM Directive 9200.2-177. Memorandum: Recommendations for Default Age Range in the IEUBK Model (EPA, 2017c)

Input from site stakeholders was considered in the development of the conceptual exposure model (CEM) and interim deliverables for the HHRA. A full list of meetings and correspondence with stakeholders can be found in Appendix A of the RI report. In addition, EPA's Technical Review Workgroup for Metals and Asbestos Lead Committee was consulted regarding the approach for lead evaluation for the OU5 study area.

In addition to the above EPA guidance documents and stakeholder input, the following reports were used to characterize exposure to media within the OU5 study area by tribal members and citizens of the surrounding communities and general public.

- Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc. (Harper, 2008)
- Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Report of Grant Number EPA-STAR-J1-R831046 (Harper, 2007)
- The Spokane Tribe's Multipathway Subsistence Exposure Scenario and Screening Level Reasonable Maximum Exposure (RME) (Harper et al., 2002)
- Shoshone-Bannock Exposure Scenario for Use in Risk Assessment: Traditional Subsistence Lifeways. Shoshone-Bannock Tribes Environmental Waste Management Program (S-B EWMP, 2016)
- A longitudinal study of mercury exposure associated with consumption of freshwater fish from a reservoir in rural south central USA (Dong et al., 2015)
- Edible wild plants growing in contaminated floodplains: implications for the issuance of tribal consumption advisories within the Grand Lake watershed of northeastern Oklahoma, USA (Garvin et al., 2017)
- Final Human Health Risk Assessment for the Coeur d' Alene Basin Extending from Harrison to Mullan on the Coeur d' Alene River and Tributaries, Remedial Investigation/Feasibility Study (RI/FS). (TerraGraphics, 2001).

- Zinc and lead poisoning in wild birds in the Tri-State Mining District (Oklahoma, Kansas, and Missouri) (Beyer et al., 2004)
- Pancreatitis in wild zinc-poisoned waterfowl. (Sileo et al., 2003)
- Adverse Health Effects in Canada Geese (*Branta canadensis*) Associated with Waste from Zinc and Lead Mines in the Tri-State Mining District (Kansas, Oklahoma, and Missouri, U.S.A.) (van de Merwe et al., 2011)

1.2 Report Organization

This report is organized as follows:

- **Section 1, Introduction.** Provides an overview of the purpose, regulatory framework, and scope of work for this HHRA.
- **Section 2, Site Characteristics and Potential Receptors.** Discusses site description, site history, demographics, and land use.
- **Section 3, Data Evaluation.** Describes the analytical data used in the HHRA, development of data groupings, and methods and results of the chemical of potential concern (COPC) selection process.
- **Section 4, Exposure Assessment.** Discusses the conceptual site model (CSM) including identification and characterization of potential exposure scenarios, exposure pathways quantified in the HHRA, and quantification of exposure including calculation of exposure point concentrations (EPCs), identification of exposure factors, and estimation of COPC intakes.
- **Section 5, Toxicity Assessment.** Describes sources of quantitative oral and inhalation toxicity values (non-carcinogenic and carcinogenic) and derivation of dermal toxicity values.
- **Section 6, Risk Characterization.** Describes the methods used to characterize non-carcinogenic hazard and carcinogenic risk by integrating information provided in the exposure assessment (Section 4) and toxicity assessment (Section 5). Presents numerical estimation of hazard and risk for the potential exposure scenarios and discusses uncertainties associated with the HHRA outcomes. Analysis of lead was performed separately and is presented in Appendix E.
- **Section 7, References.** Provides a list of references used in preparing the HHRA.
- **Tables and Figures.** Tables and figures are located at the end of the HHRA behind the Tables and Figures dividers.
- **Appendices.** The following appendices, providing supplemental and supporting information, are also included in this report:
  - Appendix A, Response to Comments on Interim HHRA Deliverables
  - Appendix B, RAGS Part D Tables
  - Appendix C, Data Grouping and Sample Lists
  - Appendix D, ProUCL Output
  - Appendix E, Analysis of Lead Exposure
  - Appendix F, Uncertainty Analysis

SECTION 2

Site Characteristics and Potential Receptors

Generally, OU5 is defined by EPA Region 6 as sediments and surface water in perennially flowing creeks, streams, and rivers that may be impacted by historical mining activities within the Oklahoma portion of the TSMD and upstream portions in Kansas and Missouri. The potential exposures addressed under OU5 are associated with the aquatic environment. Terrestrial small game and large game ingestion scenarios were addressed under the OU4 HHRA (EPA, 2006). The definition of OU5 has been further refined by EPA Regions 6 and 7 for the purposes of conducting the RI and HHRA to include the following seven specific watersheds that flow downstream from EPA Region 7 states (Kansas and Missouri) into EPA Region 6 (Oklahoma):

- Fourmile Creek (an upstream background or reference location unaffected by historical mining activities)
- Elm Creek
- Tar Creek (including Lytle Creek)
- Neosho River
- Beaver Creek
- Lost Creek
- Lower Spring River (the portion of Spring River downstream of Empire Lake in Kansas)

Locations of these seven watersheds are illustrated on Figure 2-1. The site description, site history, current/potential future land uses, and current/potential future receptors are summarized in the following subsections.

2.1 Site Description

The Tar Creek Superfund Site itself has no clearly defined boundaries, but consists of areas within Ottawa County, Oklahoma, that have been impacted by historical mining wastes. Historical lead and zinc mining was conducted in an area known as the Picher Field in northern Ottawa County where hazardous substances from mining or milling were stored or disposed. The principal communities within the mining area include Commerce and Quapaw, and the former Oklahoma mining towns of Cardin, Picher, and Hockerville. Similar historical mining and waste disposal practices were performed in southeastern Kansas and southwestern Missouri; these areas combined with the Tar Creek Superfund Site in northeast Oklahoma comprise an area known as the TSMD. The TSMD, the OU5 study area boundary, EPA regional and state boundaries, and the various mining sites are depicted on Figure 2-2.

2.2 Site History

The TSMD consists of an area where widespread historical lead and zinc mining operations were conducted throughout the Tri-State region of Kansas and Missouri (EPA Region 7 states), and Oklahoma (EPA Region 6). The TSMD includes a total of four National Priorities List Superfund Sites in Missouri, Kansas, and Oklahoma as follows: the Cherokee County Site, Cherokee County, Kansas; the Oronogo-Duenweg Mining Belt Site, Jasper County, Missouri; the Newton County Mine Tailings Site, Newton County, Missouri; and the Tar Creek Superfund Site, Ottawa County, Oklahoma (MESL, 2010) as shown on Figure 2-2. Historical information on the TSMD and Tar Creek Superfund Site can be found in Section 2.2 of the RI report.

2.3 Demographics

Table 2-1 presents demographic data for the four counties located within the TSMD (Ottawa County, Oklahoma; Cherokee County, Kansas; Newton County, Missouri; and Jasper County, Missouri). The counties in the OU5 study area and the TSMD are shown on Figure 2-2.

2.4 Land Use and Designated Beneficial Use of Water within the OU5 Study Area

Pastureland, hay, or expanding residential development is the main land use in the OU5 study area, with limited industrial or commercial operations. Nearly all the native prairie and most of the forests are gone, except in riparian areas. Much of the historic Picher Mining District no longer supports vegetation due to extensive tailings remaining on the surface from the mining operations (Woods et al., 2005).

In Ottawa County, agriculture is the primary industry. Agriculture is very diversified in Ottawa County. With an annual rainfall of 40 inches, grain crops are grown with a major portion of the wheat ground double-cropped back to soybeans. Crops grown include soybeans, wheat, milo, corn, and fescue seed. Also produced are blueberries and mushrooms. In livestock production, Ottawa County has cow-calf and stocker operations. They graze mostly on fescue and Bermuda grass pastures, but there are still a few areas of native grasses in the county. Ottawa County also has chicken, turkey, dairy, and hog farming operations (Oklahoma Farm Bureau, 2018). Although it is possible that surface water from watersheds within the OU5 study area may be used for the irrigation of crops or as drinking water for livestock, its use for these purposes is unknown and expected to be unlikely due to the extent of annual rainfall in the area. Since irrigation of crops using surface water is unlikely, it was evaluated qualitatively in the HHRA.

Indigenous subsistence land uses by tribal members and citizens in the OU5 study area include hunting, gathering foods and medicine, and fishing, although these traditional activities have been influenced by modern conveniences (Harper, 2008). Land uses in the OU5 study area by tribal members and citizens include these subsistence activities as well as recreational activities (such as swimming/wading) and traditional uses such as ritual purification (sweat lodge). Potential exposure to media within the OU5 study area through these traditional land uses by tribal members and citizens are evaluated under the tribal lifeway scenario in the HHRA, which represents adults and children living a subsistence lifestyle. Recreational land uses by the general public (including adult and children) in the OU5 study area include fishing, hunting, and swimming/wading. Some other outdoor leisure activities include camping, stream access during wildlife viewing, boating, kayaking, and canoeing. Swimming is not permitted in Wildlife Department Lakes. Species to be caught with a fishing license include bass, crappie, trout, walleye, paddlefish, and alligator Gar. Paddlefish are one of the most unique fish in Oklahoma and are sought out for their fillet and roe (caviar). Additionally, turtles and bullfrogs can be caught with a fishing license. Hunting includes big game, birds, and furbearers.

Watershed-specific land use descriptions, including designated beneficial uses of the water, are summarized in Table 2-2.

2.5 Conceptual Exposure Model

The CEM builds on knowledge obtained from the CSM and conceptual contaminant transport model, and identifies the specific exposure pathways, exposure routes, and receptor populations for each medium evaluated for the OU5 study area, and specifically for the HHRA. The CEM was developed through resource and literature review, as well as observations from the CSM, and most importantly was informed based on input from site stakeholders. Tribal stakeholders, as representatives of tribal members and citizens, recommended the use of the *Quapaw Traditional Lifeways Scenario*

(Harper, 2008) as the primary basis of formulating the CEM, and the CEM relies heavily upon this resource. In addition, tribal stakeholders provided valuable input on specific exposure media that are important from both a cultural and dietary consumption standpoint.

Exposure media in the OU5 study area include sediments, surface water, and aquatic biota. The exposure media are evaluated quantitatively with the exception of irrigated crops, livestock watering, and waterfowl, which are evaluated qualitatively. The CEM is presented on Figure 2-3 (a tabulated form of the CEM is presented in Table 1 of Attachment B).

A summary of exposure scenarios evaluated quantitatively in the HHRA, including potential exposure routes and receptor populations (age group), is provided for each exposure medium below.

- **Surface water/sediment (rivers and creeks).** Hunting/fishing/gathering and recreational activities (fishing and wading) (incidental ingestion and dermal contact) for a tribal lifeway (adult and child), work activities for aquatic workers (for example, hatchery or environmental employees), and recreational activities (swimming/wading/fishing/hunting) for the general public (adult and child).
- **Surface water (rivers and creeks).** Potable use (ingestion and dermal contact) for a tribal lifeway (adult and child) and general public (adult and child).
- **Surface water (rivers and creeks).** Sweat lodge (ingestion, dermal contact, and inhalation of water vapors) for a tribal lifeway (adult and child).
- **Aquatic biota (fish, shellfish, aquatic plants, amphibians/aquatic reptiles, and semi-aquatic mammals).** Food consumption (ingestion) for a tribal lifeway (adult and child), food consumption (ingestion - fish only) for the general public (adult and child), and medicinal use (dermal - aquatic plants only) for a tribal lifeway (adult and child).

In addition to the exposure scenarios listed above, an evaluation of mine discharge was performed using the surface water scenario for both tribal lifeway and general public receptors. Mine discharge has been found to occur in a few locations within OU5 watersheds; however, the potential for exposure is expected to be highly limited because of its intermittent occurrence, typical low flow rates, and relatively low accessibility. Evaluation of this scenario is presented as part of the uncertainty analysis (Section 6.6.2.4 and Appendix F3).

SECTION 3

Data Evaluation

This section summarizes the data and methods used to develop the dataset for the HHRA, including a description of analytical data and the refinement and reduction of the data. Additionally, screening methods used to select COPCs (including specific data groupings), screening levels, and the results for COPCs identified in each data grouping are presented in this section.

3.1 Data Used in the Human Health Risk Assessment

For the RI, site stakeholders identified and contributed information, resources, and analytical data in response to a series of data requests issued by EPA. A key objective of the data acquisition for the RI was to maximize the use of this vast amount of site knowledge, resources, and analytical data to help complete the evaluation. To optimize the use of existing literature and data, the usability of available data and reports was evaluated as part of a data gap assessment (described by the Data Gap Summary Report [CH2M, 2017]). A compilation of historical resources that were assessed is presented in Appendix D of the RI report.

Historical analytical data (data collected by various investigators and sampling programs before 2017), data obtained in a 2017 investigation (performed at the recommendation of the Data Gap Summary Report [CH2M, 2017]), and a 2017 fish analytical dataset provided by Oklahoma Department of Environmental Quality (ODEQ), are combined and used in the HHRA. While the list of historical resources is long (Appendix D of the RI report), only a small number of these resources met data quality objectives and were identified as usable for the RI and HHRA through the data gap analysis process (CH2M, 2017).

The combined data for the HHRA were grouped by watershed and exposure medium for specific exposure scenarios evaluated in the HHRA. A description of the data groupings used in the HHRA and the number of samples for each grouping are discussed by exposure medium in the following subsections and summarized in Table 3-1. More detailed information about the data groups and specific sample lists for each data group are presented in Appendix C. The analytical dataset used in the HHRA is included in Section 6 of the RI report.

For samples with field duplicate analyses, the higher of the two concentrations was used to estimate the EPCs when both values were detects or non-detects. In cases where one result was a detect and the other a non-detect, the detected value was used to estimate the EPCs.

3.1.1 Sediment

The sediment dataset is composed of sediment samples collected from perennially flowing creeks, streams, and rivers within all six watersheds (Elm Creek, Tar Creek, Neosho River, Beaver Creek, Lost Creek, and Lower Spring River) within the OU5 study area from 2004 to 2017. The data presented in this section are in two categories: (1) data collected during the 2017 Data Gap Investigation, and (2) historical data (collected prior to the 2017 Data Gap Investigation). Historical data include samples collected during investigations performed from 2004 to 2017. The 2017 Data Gap Investigation was performed by CH2M, and samples were collected in accordance with the sampling procedures outlined in Section 3 of the RI report. The sediment sample locations are shown on Figure 3-1 of the RI report.

Samples were collected from saturated sediment that is within the defined “wet” banks of each creek/river, meaning the location was perennially under water. Co-located sediment samples were collected after the surface water or biota sample was collected to prevent disturbance of the sediment that may be suspended or deposited on the other media. In some instances, the co-located sediment

samples associated with biota samples were collected at a shallower depth to coincide with the habitat of that specific biota (for example, root zones).

The sediment dataset is composed of unsieved and sieved sediment samples. The unsieved sediment dataset includes 257 samples, which includes historical sediment samples that were screened using a 2.0-millimeter mesh. The sieved sediment dataset includes 206 sieved samples that were screened using a 63-micrometer (µm) or a 250-µm sieve, or in some instances, both sieve sizes. The sample summary in Appendix C, Table 1a includes information on the number of sieved and unsieved samples.

The HHRA evaluated sediment samples collected between 0 and 12 inches below sediment surface (bss). The 0- to 12-inch dataset includes sediment samples collected from the following discrete-depth intervals:

- 0 to 6 inches bss
- 0 to 8 inches bss
- 0 to 12 inches bss

Although deep unsieved sediment samples were collected from an interval of 0 to 18 inches bss, these samples were not included in the dataset used in the HHRA because they were collected at a depth at which contact is not expected to occur and because there was sufficient data coverage with the samples collected from shallower depths where most contact is expected.

Sediment samples collected as part of the 2017 Data Gap Investigation were analyzed for metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. The historical dataset contains samples analyzed for various metals that may be different from the 2017 Data Gap Investigation, including many samples that were analyzed for cadmium, lead, and zinc only.

For the purpose of COPC selection, a “sitewide” sediment dataset composed of both unsieved and sieved samples from all six watersheds was used (a total of 463 samples). In the subsequent exposure estimation and risk characterization section, the watershed-specific maximum of the unsieved and sieved samples for each COPC was selected, yielding six individual sediment datasets and associated risk evaluations (performed on a watershed-specific basis).

3.1.2 Surface Water

The surface water (total metals) dataset consists of 2,207 surface water samples that were collected from perennially flowing creeks, streams, and rivers within all six watersheds (Elm Creek, Tar Creek, Neosho River, Beaver Creek, Lost Creek, and Lower Spring River) in the OU5 study area from 2000 to 2017. Many of these samples were collected over various years from the same sampling location under prescribed sampling programs. The data presented in this section are in two categories: (1) data collected during the 2017 Data Gap Investigation, and (2) historical data (collected prior to the 2017 Data Gap Investigation). Historical data include samples collected during investigations performed from 2000 to 2017. The 2017 Data Gap Investigation was performed by CH2M, and samples were collected in accordance with the sampling procedures outlined in Section 3 of the RI report. The surface water sample locations are shown on Figure 3-2 of the RI report. Surface water samples with co-located biota and sediment sample locations are also shown together on the individual biota figures for fish, mussels, and aquatic plants.

At locations where co-located sediment and/or biota samples were collected, the surface water sample was collected first. Samples were collected from water within the defined “wet” banks of each creek/river and within approximately 2 meters of the actual sediment or biota sample location. If co-located samples could not be collected in real-time (that is, at the same time as biota collection was performed by a volunteer), the team returned to the sample location as soon as reasonably possible to collect the co-located surface water sample. Water samples were collected as close to the centerline

of the water channel as possible. At locations that were not wadable (for example, where a boat would be required to access the centerline of the channel), surface water sampling was not performed.

Surface water (total metals) samples collected as part of the 2017 Data Gap Investigation were analyzed for the following metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. The historical dataset contains samples analyzed for various metals that may be different from the 2017 Data Gap Investigation, including many samples that were analyzed for cadmium, lead, and zinc only.

Similar to the sediment dataset, for the purpose of COPC selection, the surface water dataset was composed of "sitewide" surface water (total metals) samples from all six watersheds combined. In the subsequent exposure estimation and risk characterization, the "sitewide" surface water (total metals) dataset was divided by watershed and risk evaluation was performed on a watershed-specific basis. Additionally, as a supplemental evaluation, the exposure estimation and risk characterization of dissolved metals in surface water was performed on a watershed-specific basis in the uncertainty section.

3.1.3 Mine Discharge

In addition to the obvious aboveground mining remnants, mining activities left an extensive network of underground mine workings. In some areas, the roofs of the mines have collapsed into the mine workings, creating subsidence features that extend to the ground surface. When the mines were active, groundwater pumping was required to maintain access to the tunnels. When mining operations ceased, pumping was discontinued. Many mine shafts were also abandoned and left open.

The cessation of pumping resulted in groundwater flow back into the mine workings (CH2M, 2016b). Also, surface water began flowing into the mine workings through numerous inflow points including the subsidence features and abandoned mine shafts (EPA, 2005b). As the mine voids began to flood, chemical weathering products such as acidity, metal ions, iron precipitates, and sulfates began to accumulate in the water (Sutter, 2008). A notable physical attribute of the mine discharge on the surface is the vivid orange-stained stream beds from the precipitation of ferric oxyhydroxide, which is both an aesthetic issue and a toxicity issue with the aquatic ecosystems (Younger et al., 2002).

Direct mine discharge is known to exist in three primary areas of the OU5 study area:

- **Commerce area discharges.** These discharge into an unnamed tributary of Tar Creek; the discharges are currently being treated by passive treatment systems and therefore were not investigated as part of the RI.
- **Tar Creek area discharges.** These are in the vicinity of East 40 Road and the Douthat Bridge over Tar Creek.
- **Beaver Creek area discharges.** These are located on both the north and south sides of East 50 Road along Beaver Creek.

Although potential exposure to mine discharge is expected to be highly limited because of its intermittent occurrence, typical low flow rates, and relatively low accessibility, mine discharge occurs in a few locations within OU5 watersheds. Evaluation of mine discharge was performed using surface water exposure scenarios for both tribal lifeway and general public receptors and is presented in the uncertainty analysis (Section 6.6.2.4 and Appendix F3).

3.1.4 Aquatic Biota

The perennially flowing rivers and creeks of the OU5 study area support a wide variety of biota that currently may be, or in the past have been, exposed to metals in site sediments and surface water.

Potentially exposed aquatic biota include fish, shellfish, aquatic plants, amphibians/aquatic reptiles, and semi-aquatic mammals, and are the focus of the HHRA. Aquatic biota samples were collected from and near the OU5 study area creeks and rivers in various settings. The data presented in this section are in two categories: (1) data collected during the 2017 Data Gap Investigation, and (2) historical data (collected prior to the 2017 Data Gap Investigation). Historical data include samples collected during investigations performed from 2003 to 2017. The 2017 Data Gap Investigation was performed by CH2M, and samples were collected in accordance with the sampling procedures outlined in Section 3 of the RI report.

All samples collected as part of the 2017 Data Gap Investigation were analyzed for the following metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, and zinc. The historical dataset contains samples analyzed for various metals that may be different from those analyzed in the 2017 Data Gap Investigation.

Because dietary consumption rates are provided on a wet weight basis, all biota datasets used in the HHRA are also presented on a wet weight basis. Some of the historical data (e.g., mussels and aquatic plants) were reported as dry weight, and a dry-weight-to-wet-weight conversion was needed to provide consistent reporting format in the dataset. The conversion from dry weight to wet weight was performed using the moisture content of the samples. EPA guidance provides the equation for the conversion (EPA, 2011). More detailed information about the dry-to-wet-weight conversion is presented in Section 6 (Tables 6-44 and 6-47) of the RI report.

Aquatic biota samples were combined for all six watersheds for each biota category (e.g., fish, shellfish, aquatic plants, amphibians/aquatic reptiles, and semi-aquatic mammals) into a “sitewide” dataset for the purpose of COPC selection as well as the subsequent exposure estimation and risk characterization to account for mobility of tribal lifeway receptors and mobility of animals with an extended home range (e.g., raccoons). Additionally, as a supplemental evaluation of the potential risks associated with biota consumption, the exposure estimation and risk characterization of food consumption pathways was performed on a watershed-specific basis in the uncertainty section.

3.1.4.1 Fish

Tribal members and citizens have indicated that they consume fish in three ways: (1) fillets only, (2) entire head including bones (in soups), and (3) whole fish eviscerated (organs removed) including bones but with the head removed (CH2M, 2016b). Fish were obtained from all OU5 study area watersheds. In some instances, particularly in the Neosho River and Lower Spring River, fish samples from the 2017 Data Gap Investigation were obtained at or near historical fish sampling locations. However, in many instances, fish samples were obtained from Elm Creek, Tar Creek, Beaver Creek, and Lost Creek for the first time (i.e., fish samples from these creeks were not available in the historical dataset). Fish sampling locations are illustrated on Figure 3-4 of the RI report.

Fish were collected from the watersheds with the help of volunteers in the 2017 Data Gap Investigation. Fish collection locations were determined based on input from EPA, ODEQ, Oklahoma Department of Fish and Wildlife, and tribal stakeholders. ODEQ collected fish samples by boat electroshocking. The Paddlefish Research Center also collected game/non-game fish and paddlefish samples by use of rod and reel. Preferentially and as feasible, larger fish were targeted for collection as requested by the Tar Creek Trustee Council Indian Tribes (TCTCIT) (CH2M, 2016b). For game fish, the size limitations and collection of game fish was compliant with the state fishing regulations. Collection of non-game fish is not subject to a size or daily catch limit, and Larry Tippit (Environmental Specialist, Peoria Tribe) suggested sampling non-game fish from 3 to 5 pounds (CH2M, 2016b). Non-game fish samples in this weight size were often not available during the sample collection efforts.

Samples were collected from the following non-game fish and game fish species:

- **Non-game fish.** Freshwater drum, common carp, smallmouth buffalo, and red horse fish species.
- **Game fish.** Largemouth bass, smallmouth bass, green sunfish, white crappie, bluegill, channel catfish, yellow bullhead catfish, black bullhead catfish, longear sunfish, white bass, spotted bass, blue catfish, flathead catfish, and black crappie fish species.

Although the State of Oklahoma considers bluegill, sunfish, yellow and black bullhead catfish, and flathead catfish to be non-game fish (ODWC, 2015), for the purpose of the RI analytical datasets and the HHRA, bluegill, green and hybrid sunfish, and all catfish were included within the game fish category for evaluation of fish consumption by the general public. It is common practice for the general public and tribal members and citizens to consume these fish, regardless of their game or non-game classification, and this adjustment ensures that they are assessed for both the general public and tribal member and citizen exposures.

Each whole fish was subdivided into sample portions consisting of a fillet, head, and carcass, which were weighed and analyzed individually, resulting in three fish tissue samples analyzed for each whole fish. The "total" concentrations of metals in whole fish were calculated based on the weights and concentrations of metals from the three sample portions, as discussed in Section 5.3.3 of the RI report. The estimated "total" concentrations in the 80 whole fish collected in the 2017 Data Gap Investigation were used for the fish consumption under the tribal lifeway exposure scenario because tribal members and citizens consume the entire fish for various dishes (e.g., head soup). Note that an uncertainty analysis was performed to evaluate differences in lead concentration between the whole fish and each fish body part (head, fillet, and carcass) in Section 6.6.1.5.

The data used for the evaluation of fish consumption by the general public were limited to game fish species only, because members of the general public most likely consume game fish species as food. The general public fish data group (game fish fillet) was composed of 101 samples, including 62 game fish fillet samples collected during the 2017 Data Gap Investigation, 33 fish fillet samples collected by ODEQ in 2017 (analyzed for only cadmium, lead, and zinc), and 6 paddlefish fillet samples.

3.1.4.2 Shellfish

Shellfish were collected as part of the RI to support the HHRA. Harper (2008) cites the importance of mussel collection and consumption to tribal subsistence practices. As discussed in the Data Gap Summary Report (CH2M, 2017), Asian clams were anticipated to be used as a surrogate for mussels. However, during the 2017 Data Gap Investigation, CH2M conducted multiple Asian clam surveys within each study area creek/river, and concluded that very limited populations of Asian clams were available for sampling. Therefore, the plans to collect Asian clams were revised, and traditional freshwater mussels were targeted as well. These findings were supported by consultations and field observations shared with the U.S. Geological Survey, U.S. Fish and Wildlife Service (FWS), and input from tribal members and citizens. In particular, no Asian clams or freshwater mussels were observed in any of the study area tributaries that flow into the Neosho or Lower Spring Rivers.

Asian clams were collected from four locations within the Lower Spring River and one location within the Neosho River. The Asian clams that were collected were small in size (less than 1 ounce). Freshwater mussels were only observed in the Neosho and Lower Spring Rivers at locations of historical sample collection. All shellfish collected had smaller body mass, especially the Asian clams, so the samples collected were composite samples of 3 to 15 individual shellfish, depending on local availability and size distributions.

A total of 22 shellfish samples were collected within the OU5 study area in 2003, 2005, and 2017, among which 1 sample was collected from the Neosho River and 21 samples were collected from the Lower Spring River watershed. The shellfish samples collected in 2017 were analyzed based on wet weight,

while the shellfish samples collected in 2003 and 2005 were analyzed based on dry weight. In order to make the analytical results for both sample sets comparable, a dry-weight-to-wet-weight conversion factor was applied to the analytical results for the samples collected in 2003 and 2005 to make the historical analytical results comparable to the 2017 sample results. The shellfish sample locations are shown on Figure 3-5 of the RI report.

3.1.4.3 Aquatic Plants

Aquatic plants are present in OU5 study area watersheds, and some are collected by tribal members and citizens for medicinal use or consumption. Harper (2008) acknowledges the importance of plant collection and consumption to tribal subsistence practices. Tribal stakeholder representatives were consulted and their input was used to select arrowhead and duckweed as two commonly used aquatic plants that are representative plant species from the OU5 study area watersheds (i.e., sediment and surface water located in the wet or saturated areas of perennially flowing creeks, streams, and rivers in the study area).

EPA and CH2M worked with tribal members and citizens and the FWS during the 2017 Data Gap Investigation to identify appropriate sampling areas where the plants are found, and to identify the plant species in the field. After conducting multiple surveys of the study area watershed, and input from site stakeholders, the plant sample quantities collected throughout all watersheds did not meet the data gap minimum target (three samples in each watershed). Heavy rains and flooding that occurred throughout the 2017 sampling program are expected to have limited the growth and availability of the targeted plants. The limited presence of these plants is supported by the following statement made in the presentation by the nine Tribes of Ottawa County: “Tribal members indicated in surveys that they no longer can find some plants that they traditionally gathered for their family’s use” (Garvin, 2005).

The aquatic plant dataset consists of 17 aquatic plant samples collected from five of the six watersheds (Elm Creek, Tar Creek, Neosho River, Lost Creek, and Lower Spring River) within the OU5 study area in 2011 and 2017. The aquatic plant samples collected in 2017 were analyzed based on wet weight, while the aquatic plant samples collected in 2011 were analyzed based on dry weight. In order to make the analytical results for both sample sets comparable, a dry-weight-to-wet-weight conversion factor was applied to the analytical results for the samples collected in 2011 to make the historical analytical results comparable to the 2017 sample results. The aquatic plant sample locations are shown on Figure 3-6 of the RI report. Both arrowhead and duckweed were used for the evaluation of aquatic plant consumption as food, while arrowhead samples were used to evaluate aquatic plants for medicinal purposes (as salve). Additionally, as a supplemental evaluation of the potential risks associated with aquatic plant consumption as food, the exposure estimation and risk characterization of the individual plant parts was performed in the uncertainty section. Because limited data were available for individual plant parts, maximum detected concentrations were used as EPCs for this evaluation.

Arrowhead

The arrowhead plant (*Sagittaria latifolia)* is a horizontal creeper and is most recognizable by its arrowhead-shaped leaves and potato-like tubers. The arrowhead plant is most commonly found in swamps, ditches, ponds, and shallow waters. The arrowhead plant flowers in the summer with three petaled white blossoms, which are arranged in threes. The seeds normally ripen between August and September. The arrowhead tubers are egg shaped and range from 1 to 2 inches in length (USDA-NRCS, 2016). The arrowhead tuber may be consumed much like a potato, and is also used for medicinal purposes (TEMS, 2014).

Tribal members and citizens indicated that they use the arrowhead plant in three ways: (1) consumption of the washed tuber only, (2) medicinal consumption or dermal application of the washed fine roots, and (3) tea consumption from the washed leaves (CH2M, 2016b). In consideration of this, arrowhead

samples were subdivided into tubers, roots, and leaves, as feasible based on plant availability, and each part was submitted for analysis of total metals and mercury.

During the course of sampling, from July 2017 to November 2017, the team identified and tracked the status of the tuber on the arrowhead plants, but saw little development of this portion of the observed plants. The team delayed collecting samples until the final sampling event to allow the tuber time to grow; however, during the collection, some specimens were still lacking tubers, resulting in collection of leaf/stem and root only. The arrowhead plants were located in areas of ponded water along the stream, and not in the main channel.

Arrowhead plants were composited to obtain sufficient sample mass. The plants were rinsed with distilled water, weighed as a whole plant, then divided into leaves, fine roots, and tuber (if available).

Duckweed

Duckweed (*Lemna minor)* grows floating in still or slow-moving fresh water that contains a high supply of mineral nutrients. The duckweed is composed of one or multiple frond chains with one mother root per frond. This mother root decays shortly after the frond is formed, and the duckweed continues to float in water. The duckweed plant has a flattened, oval-shaped plant body, and is typically less than 1 millimeter in length (USDA-NRCS, 2016). Duckweed may be collected and prepared for consumption in soups or eaten raw in salads (TEMS, 2014).

Duckweed collected from the site had very small volume; it was not in thick mats but spread throughout a small ponded area in the stream, and not in the main channel. Duckweed plants were composited to obtain sufficient sample mass. Duckweed was collected into plastic bags, and the team removed other debris and organic matter mixed with the duckweed. The duckweed sample was then placed on a strainer, rinsed with distilled water, and placed into a new resealable plastic bag for delivery to the laboratory.

3.1.4.4 Amphibians and Aquatic Reptiles

Aquatic amphibians were not initially identified as potential exposure media for OU5 study area receptors. However, stakeholder input on this topic indicated that amphibians and aquatic reptiles could be a food source for some tribal members and citizens. To address this potential food source, the bullfrog (*Lithobates catesbeianus*) was identified as a representative species for the HHRA. While they do not spend their entire life in an aquatic environment, bullfrogs were proposed because they are exposed to OU5 study area sediments and surface water, are present within the OU5 study area watersheds, and are consumed by some tribal members and citizens and the general public. Tribal members and citizens also specified that only the rear (hind) legs of bullfrogs were consumed (CH2M, 2016b).

CH2M worked with tribal members and citizens and FWS to identify appropriate sampling areas where bullfrogs are found. Volunteers also helped to identify the bullfrog species and dispatch bullfrogs in the field. Bullfrogs were collected at night, using a flashlight to stun the bullfrogs, and most were speared with a small trident stake, although some were dispatched with a pellet gun[2]. The frogs were rinsed with distilled water, the skin was removed from only the legs, and the legs were then severed from the body of the frog. The leg tissue was not removed from the leg bones. The leg tissue was rinsed again in distilled water, placed in a resealable plastic bag, and then placed into the site freezer.

Both legs from an individual bullfrog were submitted as one sample. Many bullfrog samples collected were too small for shipment as individuals. In these cases, bullfrog legs were composited into one sample. Frog leg tissue samples were submitted to the laboratory still on the bone. The samples,

[2] Lead shot was used in the pellet guns, but because the hind leg samples were collected away from the gunshot area (in the head or main body), this is not expected to have impacted the hind leg samples.

consisting of both tissue and bone, were ground and homogenized by the laboratory prior to analysis. The meat tissue should have been removed from the bone prior to analysis, either in the field during sample preparation, or at the laboratory.

Fourteen bullfrog samples were collected within the OU5 study area. The samples were collected from five of the six watersheds: Tar Creek, Beaver Creek, Neosho River, Lost Creek, and Lower Spring River. All bullfrog samples were collected during the 2017 Data Gap Investigation. The bullfrog sample locations are shown on Figure 3-7 of the RI report.

3.1.4.5 Semi-Aquatic Mammals

According to the tribal members and citizens, semi-aquatic mammals such as raccoons are consumed by some tribal members and citizens and are common and present within all OU5 study area watersheds. Harper (2008) acknowledges the importance of semi-aquatic mammals to tribal subsistence practices. Based on the above rationale, raccoons were selected to represent semi-aquatic mammals consumed in the OU5 study area and were collected as part of the RI program. Tribal members and citizens specified that only the meat (no organs) of a raccoon is eaten (CH2M, 2016a).

Raccoons are opportunistic and adaptable, so their habitat is all of Oklahoma. Raccoons tend to be located in areas with food, water, and a suitable den site. The home range size varies from 3 hectares (7.4 acres) for females in cities, to 5,000 hectares (12,000 acres) for males in prairies. While primarily hunted for their fur, raccoons were also a source of food for tribal members and citizens and early settlers (iNaturalist, 2016).

Raccoons eat hundreds of species of plants and animals, although plants are considered the most important component of the raccoon's diet in most habitats. In the spring, however, raccoons tend to feed more on animals, including crayfish and insects, than plants. Raccoons typically eat 0.5 to 1 pound of food per day, and up to 5 pounds per day as winter approaches. The diet of the omnivorous raccoon, which is usually nocturnal, consists of about 40 percent invertebrates, 33 percent plant foods, and 27 percent vertebrates (iNaturalist, 2016).

Because historical data were not available for raccoons, samples were collected anywhere within a watershed. CH2M worked with tribal members and citizens and FWS to identify appropriate sampling areas where raccoons are found. Volunteers also helped to trap and dispatch raccoons in the field.

Collection of raccoons occurred throughout the year with the support of local licensed tribal member hunters. Both tribal members and CH2M personnel used baited live traps in conspicuously placed locations near water bodies within the watersheds. Captured raccoons were humanely dispatched by sampler volunteers with a gun[3], and the carcass was placed on ice for transportation to the site trailer. The raccoon was then either frozen until processing could be completed or immediately processed by the field team.

The raccoon was processed by collecting tissues from the back leg or haunch. If the raccoon was frozen in the site freezer, the tissue was allowed to thaw just enough to dissect the desired tissues. Care was taken to obtain a tissue sample from a location away from any wound(s). A minimum 4 ounces of tissue was required. The area of incision was rinsed with distilled water. An incision was made through the skin on the back leg. The skin was resected to expose the muscle tissue. Muscle tissue was then removed and rinsed with distilled water prior to placing in a resealable plastic bag.

Nineteen raccoon samples were collected within the OU5 study area. All raccoon samples were collected during the 2017 Data Gap Investigation. The samples were collected from all six watersheds:

[3] Ammunition containing lead may have been used in the rifles and handguns used to dispatch raccoons, but because the back haunch (rump and rear leg) samples were collected away from the gunshot area (typically in the head), this is not expected to have impacted the back haunch samples.

Elm Creek, Tar Creek, Beaver Creek, Neosho River, Lost Creek, and Lower Spring River. The raccoon sample locations are shown on Figure 3-8 of the RI report.

3.2 Identification of Chemicals of Potential Concern

The COPCs are those chemicals that have the greatest potential to cause adverse human health effects if receptors come in contact with exposure media. COPCs were selected using different approaches depending on exposure scenarios, as discussed in the following subsections.

Although a quantitative evaluation of exposure to sediment and surface water was performed on a watershed basis, COPCs were selected per exposure medium (sediment or surface water) for the "sitewide" dataset using combined data from all watersheds (i.e., "sitewide" data groupings). For the identification of sediment COPCs, the dataset consisting of both unsieved and sieved sediment data was used. Total metals (unfiltered) surface water concentrations were used to select surface water COPCs.

Lead is the primary chemical of interest at the site due to strong association with historical mining activities in the TSMD. Therefore, lead was automatically identified as a COPC regardless of receptor type (tribal lifeway, aquatic workers, or general public) or level of detected concentration. The detailed evaluation of potential lead exposure is presented in Appendix E.

3.2.1 COPC Selection for Tribal Lifeway and Aquatic Workers

Because the exposure factor values selected for the tribal lifeway and aquatic worker exposure scenarios are often greater than EPA's default exposure factor values used to develop Regional Screening Levels (RSLs), all detected chemicals in a given dataset regardless of exposure medium (sediment, surface water, and biota) were identified as COPCs for these tribal exposure scenarios, except for essential nutrients and chemicals without quantitative toxicity values (see Section 3.2.3).

3.2.2 COPC Screening Levels for General Public

For general public receptors, EPA's RSLs were used to identify COPCs. Due to the lack of default screening levels for the fish consumption pathway, all detected chemicals in fish datasets were identified as COPCs, with the exception of essential nutrients. The maximum detected concentrations in sediment and surface water were compared to the residential soil and tap water RSLs, respectively. The RSLs based on non-carcinogenic health endpoints were based on a hazard quotient (HQ) of 0.1 to account for the potential presence of multiple chemicals affecting the same target organ, while the RSLs based on carcinogenic health endpoints were based on a target excess lifetime cancer risk (ELCR) of 1×10^{-6}. For those chemicals with more than one RSL (for example, carcinogenic-based RSL and non-carcinogenic-based RSL), the lower value was selected as the final RSL for that chemical.

3.2.3 Chemicals Excluded as COPCs

Chemicals were eliminated as COPCs based on the following criteria:

- Chemicals considered essential nutrients (calcium, magnesium, potassium, and sodium) were not selected as COPCs.
- The chemicals listed below by exposure medium were 100 percent non-detected and were not selected as COPCs for that medium/data grouping.
  - Sediment – uranium
  - Shellfish – antimony, thallium, and vanadium
  - Amphibians/Aquatic Reptiles – antimony, cobalt, and vanadium
  - Semi-Aquatic Mammals – cobalt, silver, and vanadium
  - Aquatic Plants – selenium and thallium

- Chemicals without quantitative toxicity values in EPA's recommended toxicity data sources (see Section 5) were not identified as COPCs. Titanium in sediment was the only chemical excluded as a COPC based on this criterion. Uncertainty associated with elimination of chemicals without quantitative toxicity values as COPCs is discussed in Section 6.5.

3.2.4 COPC Screening Results

Results of the COPC screening process for each receptor group, by exposure scenario, are summarized in Table 3-2. More detailed information about the COPC selection process is presented in Appendix B, RAGS Tables 2.1 through 2.9. The conservative nature of the COPC screening process resulted in the majority of chemicals detected at the site being selected as COPCs, including lead. As indicated earlier, lead was identified as a COPC regardless of receptor type or level of detected concentrations. Further evaluation of COPCs is performed in subsequent sections, with the exception of lead (which is evaluated in Appendix E).

3.2.5 Background Comparison

Although background threshold values (BTVs), based on the 95/95 Upper Tolerance Limit, for sediment and surface water from RI report are shown in Appendix B, RAGS Table 2s, no detected chemicals (including lead) were eliminated as COPCs on a basis of background comparison. The results of background comparisons were used in the selection of final chemicals of concern (COCs) in the risk characterization (Section 6).

SECTION 4

Exposure Assessment

An exposure assessment is a characterization of potential exposures to site media by human receptors under current and anticipated future land use conditions, and identifies potentially complete exposure pathways for further evaluation in the HHRA. EPCs in an exposure medium were estimated and numerical exposure factor values were identified to quantify COPC exposures for the complete exposure pathways identified under each potential exposure scenario.

4.1 Human Health Conceptual Exposure Model

The CEM identifies the means by which humans may be potentially exposed to contaminants in exposure media of the OU5 study area, including the following:

- Primary and secondary sources and mechanisms of COPC release
- Transport media
- Exposure points (points of potential human contact)
- Exposure routes
- Receptor populations

The CEM was defined through resource and literature review, observations from the CSM, and most importantly, input from site stakeholders between 2016 and 2019 (details on stakeholder input and involvement are presented in Appendix A of this HHRA, and in Appendix A of the RI report). Input from tribal members and citizens recommended the use of the *Quapaw Traditional Lifeways Scenario* (Harper, 2008) as the primary basis for formulating the CEM, and the CEM relies heavily upon this resource. In addition, tribal stakeholders provided valuable information and input on exposure media that are important from both a cultural and dietary consumption standpoint.

The CEM also provides an assessment of which exposure pathways are (1) potentially complete, (2) potentially complete but expected to result in insignificant exposure, and (3) incomplete, consistent with EPA (1989) guidance. The CEM is presented on Figure 2-3**.** The CEM in a tabulated format is also presented in Appendix B, RAGS Table 1.

4.1.1 Identification of Potential Receptors

The following three potential receptor scenarios were evaluated in this HHRA:

- **Tribal lifeway scenario**. Traditional lifeway scenario identified for local tribal members and citizens.
- **Aquatic worker scenario**. For example, fish hatchery and environmental employees.
- **General public scenario.** Recreational users.

The HHRA assessed potential exposures and associated risks for two general age groups, child (ages 0 to 6) and adult, under the tribal lifeway and general public scenarios; while only adults were evaluated under the aquatic worker scenario. A brief description of the potential activities and exposure pathways assumed for each receptor scenario is provided in Table 3-1.

4.2 Exposure Pathways Quantified

In accordance with EPA (1989) guidance, only potentially complete exposure pathways were evaluated in the HHRA. To be potentially complete, the four primary elements of an exposure pathway must be present within the OU5 study area:

- Contamination source(s) and mechanism of release
- Transport medium
- Exposure point
- Exposure route to potential receptors

Although some exposure pathways included in Table 3-1 were considered complete but insignificant exposure pathways and are not expected to add appreciable risk relative to other complete exposure pathways, the exposure pathways were included in the quantitative risk estimates to assess potential current or future exposures. An assessment of the exposure pathways is included in the CEM on Figure 2-3. The CEM in a tabulated format is also presented in Appendix B, RAGS Table 1.

The potential exposure pathways quantified in the HHRA for each receptor group are indicated in Table 3-1.

4.3 Quantification of Exposure

To evaluate the potentially complete exposure pathways further, the magnitude, frequency, and duration of exposures were estimated and quantified. EPCs were computed and pathway-specific intakes were estimated. EPA guidance (1989) recommends selecting intake variable values for a given pathway so that the combination of all intake variable values results in an estimate of the RME for that pathway. The RME is the highest exposure that is reasonably expected to occur at a site (EPA, 1989).

4.3.1 Exposure Point Concentrations

Various data groupings were created based on the specific exposure medium and the geographical area (watershed) applicable to each exposure scenario, as summarized in Table 3-1. More detailed information about the data groups is presented in Appendix C, Tables 1a through 1c. The EPCs were calculated for COPCs within each data grouping. For each data grouping, the EPCs were calculated as the upper confidence limit (UCL; often the 95th percentile) of the arithmetic mean concentration. The most current statistical program (ProUCL Version 5.1.002) (EPA, 2016b) and user guide (EPA, 2015) were used to calculate the EPCs. ProUCL provides guidance and a range of parametric and nonparametric methodologies for handling datasets of different distributions. The ProUCL calculation output is presented in Appendix D. The smaller the sample size, the less reliable the UCL estimation becomes. Therefore, for a data group where less than eight samples or less than four detected concentrations were available, the maximum detected concentration was used as the EPC for that data grouping. Additionally, if the UCL of the mean was higher than the maximum detected concentration in the data grouping, the maximum detected concentration for the data grouping was used as the EPC.

4.3.2 Exposure Factors

To assess the daily COPC intake for each receptor group, numerical intake (or exposure) parameter values were selected, in combination with EPCs, to estimate the COPC intake from each complete exposure pathway. The intake factors were selected for an RME, which is the maximum exposure that is reasonably expected to occur within the OU5 study area. The intake parameter values were selected so that the combination of all parameters results in an estimate of the RME for a particular exposure pathway. By design, the estimated RME is higher than that expected to be experienced by most of the exposed population.

Intake parameter values for the RME scenario were developed for potentially complete exposure pathways and receptors (see Appendix B, RAGS Tables 4.1 through Table 4.8). Exposure factor values for tribal lifeway and aquatic worker scenarios were developed based on literature describing Native American exposure characteristics (Garvin et al., 2017; Harper, 2007, 2008; Harper et al., 2002), inputs from the Quapaw Nation and TCTCIT (2018), EPA's risk assessment guidance documents (EPA, 1989, 2004, 2014), and EPA's reports on exposure factor data (EPA, 2011, 2018a, 2018b, 2019b). Exposure factor values for the general public were developed based on EPA's risk assessment guidance documents (EPA, 1989, 2004, 2014), EPA's reports on exposure factor data (EPA, 2011, 2019b), and literature on regional fish analyses (Dong et al., 2015).

Brief descriptions of key exposure parameter values are presented below.

4.3.2.1 Tribal Lifeway (Adult and Child)

- General exposure factors
  - Body weight – 70 kilograms (kg) for adult (based on input from Quapaw Nation) and 15 kg for child receptors (EPA, 2014).
  - Exposure duration – Tribal lifeway receptors were assumed to be exposed to site media for their entire lifetime (70 years): 64 years during adulthood (Harper, 2008) and 6 years during childhood (0 to 6 years old) (EPA, 2014).
- Exposure factors for fishing, hunting, gathering, and recreational activities
  - Incidental ingestion of sediment and surface water – Ingestion rate of sediment is assumed to be the same as the soil ingestion rate (400 milligrams per day [mg/day]) presented in Harper (2008). Incidental water ingestion rate is based on the upper percentile water ingestion rate while swimming (Dufour et al., 2017), as cited in EPA's EFH 2019 update (EPA, 2019b).
  - Exposure frequency (sediment and surface water) – Adult and child receptors were assumed to be exposed to sediment and surface water within the OU5 study area at frequencies of 312 and 234 days per year (days/year), respectively. Adult exposure frequency includes days of exposure through work and non-work activities. An increased exposure frequency of 312 days/year was selected for sediment exposure by child receptors due to additional days of exposure resulting from potential contact with sediment-laden items at their home.
  - Dermal contact (surface water) – Adult and child receptors were assumed to be dermally exposed to sediment and surface water on their whole-body skin surface area for 6 hours per day.
- Exposure factors for drinking water scenario
  - Ingestion of surface water as a drinking water source – Exposure assumptions (ingestion rate, skin surface area, and dermal contact exposure time during bathing/showering) selected for this exposure scenario are consistent with EPA's default values for a residential tap water scenario, except for body weight and exposure duration discussed above and exposure frequency. In addition, an exposure frequency of 365 days/year, rather than the EPA default value of 350 days/year, was selected to account for receptors who do not leave the area during the year.

- Exposure factors for sweat lodge use
  - Ingestion of surface water as a drinking water source during sweat lodge use – Ingestion of water was assumed to be 1 liter per event (Harper, 2008) for both adult and child receptors.
  - Exposure duration – Exposure durations of 64 years for adult receptors (Harper, 2008) and 4 years for child receptors were used, assuming that child tribal members and citizens start using sweat lodges at the age of 2 based on the Quapaw Nation's input.
  - Exposure frequency/exposure time – Adult and child (ages 2 to 6) receptors were assumed to use a sweat lodge for an exposure time of 1 hour per event at a frequency of 1 event per day and 365 events per year. This combined exposure frequency/exposure time (365 events per year for 1 hour per event, or 365 hours per year) was used as a conservative approach to account for a range of exposures by tribal members and citizens. These exposure assumptions are more conservative than input provided by Quapaw Nation and TCTCIT. Based on Quapaw Nation input, children younger than 2 do not use the sweat lodge.
  - Dermal contact – Adult and child receptors were assumed to be dermally exposed to surface water over their entire skin surface area for the durations described above.
- Exposure factors for food consumption
  - Consumption rates – Consumption rates of food items were estimated based on the food ingestion rates (the baseline average Quapaw diet in Oklahoma based on an assumed 2,000 kilocalorie [kcal] daily intake) estimated for various food categories by Harper (2008).
    - Assumes that fish intake accounts for 75 percent of "aquatic and fish" intake.
    - Assumes that shellfish intake accounts for 25 percent of "aquatic and fish" intake.
    - Assumes that aquatic plants account for 100 percent of "roots and bulbs" intake. An alternative (higher) tribal lifeway plant ingestion rate is presented in Appendix F4.
    - Assumes that amphibian intake accounts for 35 percent of "small game" intake. As a very conservative approach, both amphibians/aquatic reptiles (at 35 percent of the "small game" intake rate) and semi-aquatic mammals (at 100 percent of the "small game" intake rate) were assumed to be ingested for the tribal lifeway scenario. This results in evaluation of 135 percent of the "small game" intake rate identified by Harper (2008), which overestimates intake from these aquatic food sources.
    - Assumes that semi-aquatic mammals account for 100 percent of "small game" intake.
    - Assumed child food ingestion rates are 50 percent of adult rates. A review of food consumption data in the EPA EFH (EPA, 2011) and updates (EPA, 2018a, 2018b) suggests that the fraction of child food ingestion rates to adult ingestion rates is 50 percent or less for various food categories (total vegetables, total meat, finfish, and shellfish) (see Appendix B, RAGS Table 4 Supplement C). Therefore, although these food consumption data are based on the general public in the U.S., 50 percent of adult food ingestion is considered a reasonable estimate of child food consumption rates, even for a specific subpopulation such as tribal lifeway receptors, because the specific dietary pattern of subpopulations is accounted for in the adult ingestion rates. Alternative (higher) tribal lifeway food ingestion rates for children (as a percentage of adult rates) are presented in Appendix F4.

- Exposure factors for medicinal use of plants
  - Exposure frequency – Adult and child receptors were assumed to use plant (salve) for medicinal purposes for 312 days/year.
  - Dermal contact – Plant (salve) is assumed to be applied to hands, forearms, face, lower legs, and feet.

4.3.2.2 Aquatic Workers (Adult)

- General exposure factors
  - Body weight – 70 kg for adult (based on input from Quapaw Nation).
  - Exposure frequency and duration – Exposure frequency (250 days/year) and duration (25 years) selected for this exposure scenario are consistent with EPA's default values for an industrial worker scenario (EPA, 2014).
- Exposure factors for work activities (e.g., working at fish hatchery or collecting environmental samples)
  - Incidental ingestion of sediment and surface water – Ingestion rate of sediment is assumed to be the same as soil ingestion rate (400 mg/day) presented in Harper (2008). Incidental water ingestion rate of 0.092 liter per hour is based on the upper percentile water ingestion rate while swimming (Dufour et al., 2017), as cited in EPA's EFH 2019 update (EPA, 2019b).
  - Dermal contact (surface water) – Workers were assumed to be dermally exposed to sediment and surface water through their entire skin surface area for 6 hours per day.

4.3.2.3 General Public (Adult and Child)

- General exposure factors
  - Body weight and exposure duration – Body weight (80 kg for adult) and exposure duration (20 years for adult and 6 years for child, for a total of 26 years) for general public are consistent with EPA's default values for a residential exposure scenario (EPA, 2014).
- Exposure factors for recreational activities (swimming and wading)
  - Incidental ingestion of sediment and surface water – Ingestion rate of sediment is assumed to be the same as EPA's default soil ingestion rates for a residential scenario. Incidental water ingestion rate is based on the upper percentile water ingestion rate while swimming (Dufour, 2017), as cited in EPA's EFH 2019 update (EPA, 2019b).
  - Exposure frequency (surface water and sediment) – Adult and child receptors were assumed to be exposed to sediment and surface water within the OU5 study area at frequencies of one event per day and 28 days/year (1 day/week for the months between April and October but no exposures for November through March).
  - Dermal contact (sediment) – Skin surface area and dermal adherence factors to sediment are assumed to be the same as those of EPA's default residential scenario. Adult receptors were assumed to be dermally exposed to sediment through head, hands, forearms, and lower legs, while child receptors were assumed to be dermally exposed to sediment through head, hands, forearms, lower legs, and feet.
  - Dermal contact (surface water) – Adult and child receptors were assumed to be dermally exposed to surface water through their entire skin surface area for 1 hour per event under a swimming scenario. Under a wading scenario, adult and child receptors were assumed to be

dermally exposed to surface water through the parts of their skin surface area (identified for the sediment dermal exposure above) for 2 hours per event.

- Exposure factors for drinking water scenario
  - Ingestion of surface water as a drinking water source – All of the exposure factors selected for this exposure scenario are consistent with EPA's default values for a residential tap water scenario.
- Exposure factors for fish consumption
  - Consumption rates – The consumption rate of fish was the upper 95th confidence interval of the mean fish consumption rate estimated in a study of self-identified consumers of fish from the Grand Lake watershed, Oklahoma (Dong et al., 2015). The consumption rate of fish used in the HHRA was at the upper end of the range of fish ingestion rates developed by EPA for rivers (Table 10-5 of EPA, 2011). Consistent with the approach used for the tribal lifeway scenario, the child fish consumption rate is 50 percent of the adult fish consumption rate.

4.3.3 Intake Estimate

4.3.3.1 Intake Equations

The amount of a chemical ingested or taken up across the skin is referred to as "intake" or "dose." An average daily intake (DI) of chemical is usually calculated using the following equation for ingestion and dermal contact exposure routes:

$$DI = C \cdot \left(\frac{IR}{BW} \right) \cdot \left(\frac{EF \cdot ED}{AT} \right)$$

In accordance with RAGS Part F (EPA, 2009a), potential risks associated with inhalation exposures were assessed on a concentration basis rather than an intake-based approach. Chemical-specific average exposure concentrations (ECs) were estimated for inhalation exposures by applying appropriate exposure factors and assumptions as shown in the following equation:

$$EC = C \cdot \left(\frac{ET \cdot EF \cdot ED}{AT} \right)$$

Where:

DI = Average daily intake of chemical through ingestion and dermal contact exposure routes (milligrams per kilogram of body weight per day [mg/kg-day]).

EC = Daily average exposure concentration of chemical through inhalation (milligrams per cubic meter [mg/m^3]).

C = Concentration of the chemical in the environmental medium (e.g., sediment, surface water, water vapor, or aquatic biota) to which the receptor is exposed (represented by EPC). The units are milligrams (mg) of chemical per unit of exposure medium (e.g., milligrams per kilogram [mg/kg] for sediment or food items, milligrams per liter [mg/L] for water, and mg/m^3 for water vapor).

IR = Intake rate of the exposure medium. The units are mg/day for sediment, grams per day (g/day) for food, and liters per day for surface water.

BW = Body weight of the exposed person (kg).

ET = Exposure time (hours per day). This describes how many hours a receptor is likely to be exposed to the exposure medium during a day.

EF = Exposure frequency (days/year). This describes how often a person is likely to be exposed to the exposure medium during a typical year.

ED = Exposure duration (years). This describes how long a person is exposed to the exposure medium.

AT = Averaging time (days). This specifies the length of time over which the average dose will be calculated. Usually, two different averaging times are considered: chronic exposure and lifetime exposure. Chronic exposure includes averaging times over the specified exposure duration (e.g., 64 years of exposure for adult tribal lifeway). Chronic exposure averaging times are used when estimating non-cancer hazard, while lifetime exposure uses an averaging time of 70 years when estimating ELCRs.

The last three factors—exposure frequency, exposure duration, and averaging time (and exposure time for inhalation exposure pathway)—combine to yield a factor between zero and one. Values near one indicate that exposure is nearly continuous over the specified averaging period; values near zero indicate that exposure occurs only rarely.

To quantify exposure using the two equations above, each receptor group's exposure must be estimated using exposure factors and the EPCs for the COPCs in the exposure media (e.g., sediment, surface water, or aquatic biota).

4.3.3.2 Estimation of Dermal Intake through Exposure to Water

The method presented in RAGS Part E (EPA, 2004) was used to estimate dermal exposure to COPCs in water for three exposure scenarios: (1) dermal exposure to COPCs in surface water during hunting, fishing, gathering, and recreational activities, and (2) dermal exposure to COPCs in surface water during showering as part of potable use of surface water scenario.

The dermally absorbed dose per event, DA_{event}, was calculated as follows:

$$DAD = \frac{DA_{event} \times EF \times ED \times EV \times SA}{BW \times AT}$$

Where:

DAD	=	Dermal absorption dose (mg/kg-day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
EV	=	Event frequency (events/day)
SA	=	Skin surface area (square centimeter [cm^2])
BW	=	Body weight (kg)
AT	=	Averaging time (days)

$$DA_{event} = K_p \times C_w \times t_{event} \times CF1$$

Where:

DA_{event}	=	Absorbed dose per event (milligrams per square centimeter [mg/cm^2]-event)
Kp	=	Permeability coefficient from water through skin (centimeters per hour)
Cw	=	Concentration of chemical in water (mg/L)
t_{event}	=	Duration of event (hours per event)
CF1	=	Conversion factor (0.001 liter per cubic centimeter)

The calculation of dermally absorbed dose per event is presented in Appendix B, RAGS Table 7 Supplemental tables.

4.3.3.3 Estimation of Dermal Intake through Exposure to Salve

The method developed in RAGS Part E (EPA, 2004) to estimate dermal exposure to chemicals in soil was used to estimate dermal exposure to COPCs in salve under a scenario evaluating medical use of aquatic plants (using arrowhead plant data). Because adherence factor and the salve-to-skin dermal absorption fraction specific to this scenario are not readily available, the soil-to-skin adherence factor and dermal absorption fraction for chemicals in soil were used to estimate dermal absorption dose of COPCs in aquatic plants during their medicinal use.

The dermally absorbed dose was estimated using the following equation:

$$DAD = \frac{C_{plant} \times EF \times ED \times AF \times ABS_d \times SA \times CF2}{BW \times AT}$$

Where:

DAD	=	Dermal absorbed dose (mg/kg-day)
C_{plant}	=	Concentration of COPC in plant (mg/kg)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AF	=	Adherence factor of soil to skin (mg/cm^2-event)
ABS_d	=	Dermal absorption fraction (unitless)
SA	=	Skin surface area (cm^2)
CF2	=	Conversion factor (kilograms per milligram)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

4.3.3.4 Estimation of Inhalation of COPCs in Water Vapor

The EPCs of the COPCs in water vapor were modeled for the evaluation under a sweat lodge exposure scenario in accordance with the methodology presented in Section I of Shoshone-Bannock Exposure Scenario for Use in Risk Assessment (S-B EWMP, 2016). The specific equation and input parameter values are presented in Appendix B, RAGS Table 4.5.

$$C_v = C_{sw} \times \left(\frac{MW_w}{R \times T \times \rho_w}\right) \times EXP\left(18.3036 - \frac{3816.44}{T - 46.13}\right)$$

Where:

C_v	=	COPC concentration in water vapor (mg/m^3)
C_{SW}	=	COPC concentration in surface water (mg/L)
MW_w	=	molecular weight of water (18 grams per mole [g/mol])
R	=	ideal gas law constant (0.06237 millimeters mercury per cubic meter per mole degrees Kelvin [mmHg·m^3]/[mol·K])
T	=	temperature of the sweat lodge (339 degrees Kelvin [or 66 degrees Celsius)
ρ_W	=	density of liquid water (1,000 grams per liter)

4.3.4 Approach for Mutagenic Exposures

COPCs with a mutagenic mode of action (MMOA) require separate exposure estimations for age ranges 0 to <2, 2 to <16, and 16 and older due to toxicity adjustments required for younger age ranges (EPA, 2005b, 2005c). Although speciated chromium data are not available, chromium in surface water was conservatively assumed to be 100 percent in the hexavalent chromium, or Cr (VI), form, which acts through an MMOA. Age-specific toxicity values are not available for Cr (VI); therefore, EPA's default age-dependent adjustment factors (ADAFs) were applied to the cancer slope factor (CSF) and inhalation unit risks (IURs) for Cr (VI) for childhood and early-life exposure to surface water by potential child tribal lifeway and general public receptors.

Tribal lifeway adult/child aggregate exposure (surface water):

$$\text{Aggregated DI} = \sum DI_i \times ADAF_i$$

$$= DI_{(0-<2\ years)} \times 10 + DI_{(2-<6\ years)} \times 3 + DI_{(6-<16\ years)} \times 3 + DI_{(16-<26\ years)} \times 1$$

Where:

DI = *daily intake*
i = *"i"*th age groups as follows.
ADAF = age-dependent adjustment factor, as follows:

Age of Exposure	ADAF
0 to less than 2 years	10
2 to less than 6 years	3
6 to less than 16 years	3
16 and older	1

4.3.5 Approach for Arsenic Speciation

Arsenic exposures through consumption of food were evaluated based on the fraction of arsenic species likely to be present in these food items. The form of arsenic in food items (fish, shellfish, plants, amphibians, and semi-aquatic mammals) was assumed to be 10 percent inorganic arsenic and 90 percent organic arsenic. This assumption of 10 percent of arsenic being in the inorganic form is made based on EPA's technical document, *Technical Summary of Information Available on the Bioaccumulation of Arsenic in Aquatic Organisms* (EPA, 2003c). This document indicates that "The consensus in the literature is that upwards of 85 percent to more than 90 percent of arsenic found in edible portions of marine fish and shellfish is organic arsenic (arsenobetaine, arsenocholine, or dimethylarsinic acid) and that approximately 10 percent is inorganic arsenic" (De Gieter et al., 2002; Goessler et al., 1997; Johnson and Roose, 2002; Ochsenkühn-Petropulu et al., 1997). Therefore, 10 percent of the arsenic concentration in food items was used to estimate carcinogenic risks and non-carcinogenic hazards in the HHRA.

SECTION 5

Toxicity Assessment

This section describes the oral, dermal, and inhalation toxicity values (non-carcinogenic and carcinogenic) used in estimating potential adverse health effects for COPCs at the site.

The oral toxicity values (CSFs and reference doses [RfDs]) and inhalation toxicity values (IURs and reference concentrations [RfCs]) used in the HHRA were obtained from the EPA standard hierarchy of toxicity value sources (EPA, 2003d), as follows:

- Tier 1 Source – Integrated Risk Information System (IRIS) (EPA, 2019c)
- Tier 2 Source – EPA Provisional Peer-Reviewed Toxicity Values (PPRTV)
- Tier 3 Sources – Other peer-reviewed federal and state toxicity values
  - Minimal risk levels identified by the Agency for Toxic Substances and Disease Registry (ATSDR, 2019)
  - California EPA toxicity database (Cal/EPA, 2019)
  - EPA's Health Effects Assessment Summary Tables (EPA, 1997a)

5.1 Non-carcinogenic Toxicity Values

Non-carcinogenic toxicity values (oral RfDs and inhalation RfCs) were used in estimating potential adverse health effects associated with exposure to COPCs. In general, the RfD and RfC are estimates (with uncertainty spanning perhaps an order of magnitude) of daily exposure to the human population (including sensitive subgroups) that are likely to be without an appreciable risk of deleterious effects during a lifetime of exposure (EPA, 1989).

5.1.1 Cadmium

Two oral RfDs are provided in IRIS for cadmium: an oral "water" RfD of $5x10^{-4}$ mg/kg-day and an oral "food" RfD for cadmium of $1x10^{-3}$ mg/kg-day (EPA, 2019c). The oral "food" RfD of $1x10^{-3}$ mg/kg-day was used to quantify potential non-carcinogenic hazard for cadmium associated with sediment ingestion and biota consumption, whereas the oral "water" RfD of $5x10^{-4}$ mg/kg-day was used to quantify potential non-carcinogenic hazard for cadmium associated with surface water ingestion.

5.1.2 Chromium

Trivalent chromium (Cr [III]) is highly insoluble and will not be found in dissolved aqueous phase unless (1) pH is very low (below 4 to 4.5), or (2) the Cr (III) is complexed by a strong bond to an organic molecule that keeps it in solution. These conditions are not observed at Tar Creek. On the other hand, Cr (VI), when stable under oxidizing conditions, is highly soluble and does not form any insoluble salts except under evaporative conditions. Therefore, it is a reasonable assumption that dissolved chromium is essentially 100 percent Cr (VI) over the common pH range. There are cases in which Cr (VI) can be incorporated into freshly precipitating calcite; however, it is not likely a case for Tar Creek.

Based on the above-mentioned characteristics of chromium at different oxidation states, Cr (VI) toxicity values were used for exposure through aqueous media such as surface water, whereas Cr (III) toxicity values were used for exposure through solid media such as sediment and food. The inhalation RfC for chromic acid mists and dissolved Cr (VI) aerosols was used for water vapor.

5.1.3 Manganese

The IRIS oral RfD for manganese (0.14 mg/kg-day) includes manganese from all sources, including diet (EPA, 2019c). Consistent with the RSL User's Guide (EPA, 2019a) and the IRIS assessment for manganese (EPA, 2019c), two separate oral RfDs were used to quantify risks for manganese in the HHRA. An oral RfD for non-diet exposures was calculated by subtracting the dietary contribution from the normal U.S. diet (an upper limit of 5 mg/day) and applying a modifying factor of 3 to address uncertainties associated with non-food manganese exposure sources, resulting in an oral "non-diet" RfD of 0.024 mg/kg-day. The oral "non-diet" RfD was used to estimate potential HQs associated with exposures to sediment and surface water. The oral "diet" RfD of 0.14 mg/kg-day was used to estimate potential risks associated with consumption of biota (fish, shellfish, plants, amphibians, and semi-aquatic mammals).

5.1.4 Mercury

Mercury was assumed to be present as mercuric chloride (and other mercury salts) in sediment and surface water, whereas mercury is assumed to be present as methylmercury in food (animal and plant tissues). Although an RfC is available for elemental mercury, this RfC was not used in the evaluation of inhalation of mercury within the OU5 study area because mercury is expected to be present as mercuric chloride (and other mercury salts) in surface water, not elemental mercury.

5.1.5 Phosphorus

Phosphorus was assumed to be present as adsorbed orthophosphate in the sediment. Although the RSL for white phosphorus was conservatively used in the COPC selection process, the RfC available in IRIS for white phosphorus was not used in the evaluation of ingestion of phosphorus in sediment within the OU5 study area because white phosphorus (which does not occur naturally) is not expected to be found at the site.

5.1.6 Vanadium

The oral RfD for vanadium (0.005 mg/kg-day) used in the HHRA was derived from the oral RfD for vanadium pentoxide (0.009 mg/kg-day). The vanadium oral RfD was calculated by factoring out the molecular weight of the oxide ion. The two atoms of vanadium contribute 56 percent of the molecular weight for vanadium pentoxide. Therefore, the oral RfD for vanadium pentoxide was multiplied by 56 percent to calculate the oral RfD for vanadium (0.005 mg/kg-day). This approach is consistent with the RSL User's Guide (EPA, 2019a).

5.1.7 Silica

The RfC presented on the RSL table is meant to be applied only to particles of crystalline silica (quartz, cristobalite, tridymite) of respirable size; therefore, the silica RfC was not used for the evaluation of silica in water vapor.

5.1.8 Thallium

Thallium was the only COPC with a PPRTV appendix toxicity value. The PPRTV for thallium and compounds document (EPA, 2012) states:

> "It is inappropriate to derive a subchronic or chronic provisional RfD for thallium. However, information is available which, although insufficient to support derivation of a provisional toxicity value, under current guidelines, may be of limited use to risk assessors…Users of screening toxicity values in an appendix to a PPRTV assessment should understand that there is considerably more uncertainty associated with the derivation of a supplemental screening toxicity value than for a value presented in the body of the assessment."

Therefore, the PPRTV appendix value was used for screening purposes only, and a quantitative evaluation of thallium was not conducted.

Non-cancer toxicity values used in the HHRA are presented in Appendix B, RAGS Tables 5.1 and 5.2.

5.2 Carcinogenic Toxicity Values

Carcinogenic toxicity values (CSFs and IURs) were used in evaluating potential carcinogenic effects associated with exposure to known, probable, or possible carcinogens having an EPA weight-of-evidence classification of A, B, or C, respectively. One exception was Cr (VI), which is not considered by EPA to have a weight-of-evidence classification of A, B, or C, but where a CSF was derived by Cal/EPA (2019). CSFs and IURs were used to estimate upper-bound lifetime statistical probabilities of a hypothetical individual developing cancer as a result of exposure to a potential carcinogen.

5.2.1 Chromium

Consistent with EPA's (November 2019) RSL table, the IUR for hexavalent chromium is derived by multiplying the IRIS hexavalent chromium IUR of 1.2×10^{-2} per microgram per cubic meter ($\mu g/m^3$) by 7. This is considered to be a health-protective assumption, and is also consistent with the State of California's interpretation of the Mancuso study that forms the basis of hexavalent chromium's estimated cancer potency.

Cancer toxicity values for COPCs are provided in Appendix B, RAGS Tables 6.1 and 6.2.

5.3 Derivation of Dermal Toxicity Values

Oral RfDs and CSFs were converted to dermal RfDs and CSFs using gastrointestinal absorption factors. The values used for this conversion were obtained from RAGS Part E, Section 4.2, and Exhibit 4-1 (EPA, 2004). Following EPA's recommendation, such a conversion was performed only when a chemical has a gastrointestinal absorption factor of less than 50 percent. If a chemical-specific gastrointestinal absorption factor was not available, gastrointestinal absorption of the chemical was assumed to be greater than 50 percent, and the oral RfD (or oral CSF) was used as the dermal RfD (or dermal CSF) without adjustment.

SECTION 6

Risk Characterization

This section provides a summary of risk characterization at the site. Potential human health risks are discussed separately for carcinogenic and non-carcinogenic health effects due to the different toxicological endpoints, relevant exposure durations, and methods used to estimate risk, with the exception of lead. The standard approach for the evaluation of lead (using multi-media biokinetic modeling) is different from other chemicals, warranting a separate evaluation and discussion; therefore, the detailed evaluation of lead is presented in Appendix E and a summary is provided below.

CERCLA specifies an acceptable site ELCR range of one in a million (1×10^{-6}) to one in ten thousand (1×10^{-4}). Generally, remedial actions are not warranted for site media with an ELCR of 1×10^{-4} or less or a hazard index (HI) of 1 or less, although it may be warranted if other site-specific information suggests to risk managers that action is appropriate. Based on the risk estimates, preliminary COCs were identified. Background comparison and the nature of mining-related contamination was used to refine the list of preliminary COCs to identify final COCs.

Potential lead exposure was evaluated in Appendix E, where a similar refinement process was applied to the results to identify if lead was a final COC. The results of the lead evaluation are incorporated into the risk characterization beginning in Section 6.5.2 (Refinement of Preliminary COCs).

6.1 Approach for Potential Non-carcinogenic Effects

The HHRA evaluated the potential for non-carcinogenic effects by comparing the exposure intakes of each COPC over a specified time period (i.e., chronic) with RfDs derived for a similar exposure period. For the inhalation exposure route, non-carcinogenic effects were evaluated by comparing the ECs of each COPC with the RfC. In EPA methodology, this ratio of exposure to toxicity is referred to as an HQ. The HQ assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects. If the exposure level exceeds this threshold, there is the potential for non-cancer health effects to occur. The HQ is calculated as follows:

$$HQ = \frac{DI}{RfD} \qquad \text{or} \qquad HQ = \frac{EC}{RfC}$$

Where:

HQ = Hazard quotient
DI = Daily Intake level (mg/kg-day)
RfD = Reference dose (mg/kg-day)
EC = Exposure concentration (mg/m^3)
RfC = Reference concentration (mg/m^3)

Intake and RfD are expressed in the same units (mg/kg-day) and represent the same exposure period. Similarly, ECs and RfCs are expressed in the same units (mg/m^3). An HQ that exceeds 1 (i.e., intake exceeds the RfD or EC exceeds the RfC) indicates that there is a potential for adverse health effects associated with exposure to that COPC.

To assess the potential for non-carcinogenic health effects posed by exposure to multiple COPCs and exposure routes, an HI approach was used (EPA, 1989). This approach assumes that non-carcinogenic hazards associated with exposure to more than one COPC and exposure route are additive. Synergistic or antagonistic interactions between COPCs are not quantified. The HI may exceed 1 even if all of the individual HQs are less than 1.

The HI is equal to the sum of the HQs and is calculated as follows:

$$HI = \frac{DI_1}{RfD_1} + \frac{DI_2}{RfD_2} + \cdots \frac{DI_i}{RfD_i} + \frac{EC_1}{RfC_1} + \frac{EC_2}{RfC_2} + \cdots \frac{EC_j}{RfC_j}$$

Where:

HI = Hazard index
DI = Daily intake level (mg/kg-day)
RfD = Reference dose (mg/kg-day)
I_i = Intake level for the "*i*"th constituent
RfD_i = Reference dose for the "*i*"th constituent
EC = Exposure concentration (mg/m^3)
RfC = Reference concentration (mg/m^3)
EC_j = Exposure concentration for the "*j*"th constituent
$RfCj_i$ = Reference concentration for the "*j*"th constituent

6.2 Approach for Potential Carcinogenic Effects

The potential for carcinogenic effects due to exposure to site media was evaluated by estimating the ELCR. The ELCR is the incremental increase in the probability of developing cancer during one's lifetime (as a result of exposure to site media) above the probability of developing cancer from non-site exposures.

Potential ELCRs associated with exposure to individual carcinogens were calculated using CSFs and chemical intakes for oral and dermal contact exposures, and IURs and ECs for inhalation exposures. The linear low-dose equation was used to estimate the incremental probability of an individual developing cancer over a lifetime as a result of exposure to potential carcinogens. Estimated ELCRs are calculated by multiplying the DI by the CSF or EC by the IUR:

$$ELCR = DI \times CSF \quad \text{or} \quad ELCR = EC \times IUR$$

Where:

ELCR = Excess lifetime cancer risk
DI = Daily intake level (mg/kg-day)
CSF = Cancer slope factor $(mg/kg\text{-}day)^{-1}$
EC = Exposure concentration ($\mu g/m^3$)
IUR = Inhalation unit risk $(\mu g/m^3)^{-1}$

The theoretical probability of developing cancer as a consequence of exposure to two or more COPCs and by two or more exposure pathways was calculated by summing the risk estimates for each COPC in the appropriate scenarios using the following equation:

$$Total\ ELCR = (DI_1 \times CSF_1) + (DI_2 \times CSF_2) + \ldots (DI_i \times CSF_i) +$$

$$(EC_1 \times IUR_1) + (EC_2 \times IUR_2) + \ldots (EC_i \times IUR_i)$$

Where:

ELCR = Excess lifetime cancer risk
DI = Daily intake level (mg/kg-day)

CSF = Cancer slope factor $(mg/kg\text{-}day)^{-1}$
I_i = Intake level for the "*i*"th constituent
CSF_i = Cancer slope factor for the "*i*"th constituent
EC = Exposure concentration $(\mu g/m^3)$
IUR = Inhalation unit risk $(\mu g/m^3)^{-1}$
EC_j = Exposure concentration for the "*j*"th constituent
IUR_j = Inhalation unit risk for the '*j*'th constituent

6.3 Approach for Lead

Potential lead exposure was evaluated using the IEUBK Model for Lead in Children, Windows, Version 1.1, Build 11 (EPA, 2010) and the Adult Lead Methodology (ALM) (EPA, 2017a). Recently updated (but not yet available to the public) default lead intake values for food consumption were used in the IEUBK model (Appendix E, Table 2). The lead analysis is presented in Appendix E.

The IEUBK model provides predictions of blood lead levels (BLLs) for children ages 0 to 7 years old with exposure to lead in various media. The IEUBK model results are expressed as the predicted geometric mean (GM) BLL for children and the percentage of the child population with potential BLLs above the target BLL. Based on EPA OLEM policy (EPA, 1994a), which strives to reduce lead exposure levels so that there is no more than a 5 percent probability that children exposed to lead will exceed a BLL of 10 µg/dL, 10 µg/dL was used as a target BLL. Additionally, the current scientific literature on lead toxicology and epidemiology provides evidence that adverse health effects are associated with BLLs less than 10 µg/dL (EPA, 2016a). Therefore, lead exposure was assessed using two additional, lower target BLLs (5 and 8 µg/dL) to provide additional information for comparison.

The ALM model was used to calculate potential BLLs for the aquatic worker scenario. The model results are expressed as the predicted GM BLL and the corresponding 95th percentile fetal BLLs, and the probability that fetuses exposed to lead will exceed a BLL above the same set of target BLLs (5, 8, and 10 µg/dL) used in the IEUBK model.

6.4 Summary of Risk Estimates

Potential risk associated with exposures to COPCs in the site media were quantified for the RME scenarios identified below:

- **Current/Future Tribal Lifeway.** Sediment (incidental ingestion and dermal contact) and surface water (incidental ingestion and dermal contact) exposure during hunting, fishing, gathering, and recreational activities; surface water as a drinking water source (ingestion and dermal contact); surface water exposure during sweat lodge use (ingestion, dermal contact, and inhalation); food consumption (ingestion of fish, shellfish, aquatic plants, amphibian/aquatic reptiles, and semi-aquatic mammals); and medicinal use of plants (dermal contact).
- **Current/Future Aquatic Workers.** Sediment (incidental ingestion and dermal contact) and surface water (incidental ingestion and dermal contact) exposure during work activities.
- **Current/Future General Public.** Sediment (incidental ingestion and dermal contact) and surface water (incidental ingestion and dermal contact) exposure during recreational activities; surface water as a drinking water source (ingestion and dermal contact); and food consumption (ingestion of fish).

Tables 6-1 through 6-5 summarize the risk estimates for each watershed. Additional detailed information about risk estimates is presented in Appendix B, RAGS Tables 7.1 through 7.42 and 9.1 through 9.42.

6.5 Chemicals of Concern

COCs were identified using a step-wise process, as summarized on Figure 6-1. First, preliminary COCs were identified based on the results of the HHRA. Preliminary COCs are chemicals that drive risks based on the results presented in RAGS Part D Table 9s and the lead model output, without regard for background levels or relation to sources associated with historical site activities. Second, the list of preliminary COCs was refined using two refinement processes (background comparison, and nature of mine-related contamination) to identify the final COCs. Final COCs take background levels and attribution to site sources into account. The following subsections provide detailed information regarding the COC selection and refinement processes.

6.5.1 Identification of Preliminary COCs

Preliminary COCs are identified for a receptor scenario when the potential ELCR or HI exceeds EPA threshold values (a total ELCR of 1×10^{-4} or a target-organ-specific HI of 1), with the exception of lead (which is based on the lead model outputs, as presented in Appendix E). When a target ELCR of 1×10^{-4} is exceeded for an exposure medium for the receptor scenario, the COPCs posing an individual ELCR greater than 1×10^{-6} in the environmental medium were identified as preliminary COCs. When a target-organ-specific HI of 1 is exceeded for an exposure medium for the receptor group, the COPCs posing an HQ greater than 0.1 for that target organ in the environmental medium responsible for the unacceptable HI are identified as preliminary COCs. Because child receptors have higher HI estimates than adult receptors, the preliminary COCs for non-carcinogenic endpoints were identified based on the HHRA results for child receptors under tribal lifeway and general public exposure scenarios. Tables 6-1 through 6-5 summarize preliminary COCs for each receptor scenario by watershed.

6.5.2 Refinement of Preliminary COCs

The lists of preliminary COCs were refined using a two-step refinement process (background comparison, and nature of mine-related contamination). This process is consistent with EPA guidance on HHRA (EPA, 1989, 2002).

- When statistical background comparison (central tendency) indicates concentrations in site sediment are not greater than background, that preliminary COC was not identified as a final COC. The sediment background comparison was performed separately for sieved and unsieved datasets, when sufficient data were available. For preliminary COCs in sediment, when the background comparisons were performed on both sieved and unsieved datasets, if at least one of the datasets indicates that the site concentration is greater than background, the preliminary COC was conservatively retained for further evaluation.
- The surface water comparison to background is based on the total metals (not dissolved metals) surface water datasets for the site and background. The comparison to background is based on total metals because onsite exposures were based on total metals data.
- Preliminary COCs in biota were refined based on background comparisons of sediment data because of the complexity of performing background comparisons on the biota data and relatively small size of background biota datasets. Biological systems are complex; therefore, for instance, the concentrations of chemicals in fish tissue may not be directly compared without considering other factors potentially influencing the chemical concentrations in fish tissue, such as fish species, where they dwell in the water column, part of body sampled, and age (or size). In addition, fish, amphibians/aquatic reptiles, and semi-aquatic mammals are not stationary and may move within or between watersheds. For these reasons, preliminary COCs in biota were refined based on the background comparisons of sediment data. Background comparisons of sediment data were performed by watershed, while preliminary biota COCs were identified based on sitewide data.

Therefore, if at least one of the watershed datasets indicates that the site concentration is greater than background in sediment, the preliminary biota COC was conservatively retained for further evaluation.

For those preliminary COCs that were not eliminated based on background comparisons, further review of the preliminary COCs was performed based on nature of mine-related contamination. Literature review was performed to evaluate the likelihood of the preliminary COC being associated with TSMD ore bodies (Table 7-1 of the RI report). If the preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was not identified as a final COC. The following preliminary COCs were eliminated based on the literature review:

- Molybdenum in sediment
- Aluminum, chromium, and vanadium in surface water
- Mercury in biota

The refinement of preliminary COCs is presented in Tables 6-6 through 6-13. The final list of COCs for the OU5 study area is summarized in Table 6-14; this table also incorporates the identification of lead as a final COC as shown in Appendix E, Table 10. Hazard and cancer risk estimates for the final COCs are summarized in Tables 6-15 through 6-19. More detailed information about COC selection is presented in Appendix B, RAGS Tables 10.1 through 10.19.

6.6 Uncertainty Analysis

The methodologies and assumptions used in any HHRA have inherent uncertainty. This subsection presents a discussion of those uncertainties, as well as their effect on the estimates of potential health outcome (i.e., non-carcinogenic hazard, cancer risk, and lead exposure) in the HHRA. The discussion of their effect is largely qualitative because, in many instances, not enough information exists to quantify the magnitude of these uncertainties. While it is theoretically possible that the HHRA leads to underestimates of potential health outcome, the use of numerous upper-bound assumptions most likely results in conservative estimates.

6.6.1 General Uncertainties

The non-carcinogenic HIs and ELCRs based on RME assumptions presented in Section 6 are estimates of potential upper-bound hazard and risk that are useful in regulatory decision-making. It is improper to consider these estimates as representative of the actual health outcome to potentially exposed individuals because they were estimated by making numerous conservative assumptions (i.e., assumptions that overestimate potential exposure and potential health outcome). Some of the assumptions have a firm scientific basis, while others do not. Various degrees of uncertainty are introduced into the HHRA process every time an assumption is made, including when a default value is used. In the EPA risk assessment process, the methodology dictates that assumptions err on the side of overestimating potential exposure and health outcome. The effect of using numerous assumptions that each overestimate potential health outcome is to exaggerate estimates of potential risk. Such estimates do not provide a realistic estimate of the potential health impacts associated with a site.

General uncertainties associated with standard CERCLA HHRA methodologies and assumptions are summarized in Table 6-20, while specific uncertainties associated with the OU5 HHRA are discussed below.

6.6.2 Uncertainties Associated with OU5 Study Area-Specific Data and Data Usage

6.6.2.1 Use of Historical Data

Historical data[4] used in the HHRA were composed of samples collected by multiple stakeholders and agencies during independent sampling events for various end uses. The data used in the HHRA have been evaluated for usability in the Data Gap Evaluation (CH2M, 2017) and were deemed to be acceptable for use in an HHRA using five general assessment factors: soundness, applicability and utility, clarity and completeness, uncertainty and variability, and evaluation and review. However, as the data were collected by stakeholders and agencies using a variety of collection methods for different investigation objectives, inclusion of these datasets has introduced some degree of uncertainty to the data.

Because of the compilation of analytical datasets from multiple sampling events, the historical dataset contains analytes different from the target analytes that were selected for the 2017 Data Gap Investigation. For example, a subset of historical sediment data includes boron, lithium, phosphorus, strontium, and titanium because samples were collected and analyzed for different investigation objectives. Although these analytes are not likely to be associated with site activities, they were conservatively identified as COPCs and evaluated in the quantitative HHRA.

Additionally, historical data included a range of reporting limits within a data group. Although the range of reporting limits varied for sediment and surface water, the majority of COPCs had a relatively high frequency of detection (greater than 50 percent). Therefore, having a wide range of reporting limits itself is not likely to impact overall HHRA conclusions. However, as is typical with the use of historical datasets in HHRA, the use of compiled historical analytical datasets has introduced some degree of uncertainty to the data used in the HHRA.

6.6.2.2 Use of Sieved and Unsieved Sediment Data

Both sieved and unsieved sediment data were used in the HHRA. Generally, in HHRA, unsieved sediment data are used to evaluate potential exposure to COPCs in sediment, as they are what receptors would be exposed to in the environment during recreational activities in a body of water. Lead is an exception to this, as OLEM 9200.1-128 (EPA, 2016c) recommends sieving soil and dust samples for the assessment of incidental ingestion using the IEUBK model, because dermally adhered soil is largely made up of particle fractions <150 µm.

Soil particle size is directly related to dermal adherence and inversely associated with mobility and bioavailability. These current recommendations concerning use of sieved soil data apply to lead risk assessment but may also be applicable to other metals; however, there is no guidance specific to the use of sieved data for sediment. Based on the review of the unsieved and sieved sediment datasets (see Appendix F1, Figure 1), cadmium, lead, and zinc concentrations in sediment tend to be higher in unsieved data than sieved data, but this observation was not always consistent; therefore, all sediment data were used and the higher EPCs between the unsieved and sieved sediment datasets were selected conservatively as the final EPCs for each watershed in the HHRA (as shown in Appendix B, RAGS Table 3.2 Supplement A). This approach likely overestimates potential health outcomes associated with sediment exposure.

[4] "Historical data" are defined here as data collected prior to 2017 (that is, prior to the 2017 Data Gap Investigation).

6.6.2.3 Use of Total Metals Surface Water Data

Potential exposure associated with COPCs in surface water (exposure during hunting, fishing, gathering, recreational activities, potable use, or sweat lodge use) was evaluated based on total concentrations of metals in surface water in the HHRA. Dissolved concentrations of metals, however, would likely be a better representation of exposure for some of these exposure scenarios.

For instance, inhalation of COPCs in water vapor generated by OU5 study area surface water poured over heated rocks was evaluated based on total concentrations of metals in surface water under a sweat lodge use scenario. However, COPC concentrations in water vapor (water droplets suspended in air) are better represented by dissolved metals surface water data than total metals surface water data. Additionally, surface water could be used as a potable water source with filtration. In this case, dissolved metals surface water data would represent potential exposure better than total metals surface water data.

As part of the uncertainty analysis for the HHRA, an evaluation of potential hazard and risk for potable surface water use and sweat lodge scenarios is performed based on the dissolved metals surface water dataset for the tribal lifeway receptors (Appendix F2, Tables 1 and 2). The EPCs of dissolved metals in surface water were estimated for the final surface water COCs (identified in Tables 6-9 through 6-11) in the same way that EPCs for total metals in surface water were estimated (see Section 4.3.1). The ProUCL output used to calculate EPCs for dissolved metals in surface water is presented in Appendix F2, Tables 3 through 5. Dissolved metal EPCs are comparable to, or up to 45 percent lower than, total metal EPCs. Appendix F2, Tables 1 and 2 show the comparison of risk estimates between dissolved and total metals surface water datasets. Although lower estimations of hazard and risk were observed using the dissolved metals surface water dataset, the results in terms of the level of HI and ELCR estimates and target organ exhibiting unacceptable HI were similar between the two datasets.

6.6.2.4 Mine Discharge

Mine discharge, when it occurs in OU5 watersheds, occurs only intermittently in areas relatively inaccessible to most people (including tribal members and citizens) and typically at low flow rates. Because it does occur in OU5 watersheds, however, the detected chemicals in mine discharge were evaluated as part of the uncertainty analysis for the same exposure scenarios as surface water.

The mine discharge (total metals) dataset consists of 25 samples that were collected in 2007, 2008, and 2017: 5 samples collected from the Tar Creek watershed and 20 samples collected from the Beaver Creek watershed (Appendix F3, Table 1). Mine discharge (total metals) samples collected as part of the 2017 Data Gap Investigation were analyzed for the following metals: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. The historical dataset contains samples analyzed for various metals that may be different from the 2017 Data Gap Investigation, including some samples that were analyzed for cadmium, lead, and zinc only.

All chemicals detected in mine discharge (with the exception of the essential nutrients calcium, magnesium, potassium, and sodium) were identified as COPCs. The EPCs for total metals in mine discharge were estimated in the same way that EPCs for total metals in surface water were estimated (see Section 4.3.1). Total metal EPCs for mine discharge COPCs are summarized in Appendix F3, Table 2. The ProUCL output is presented in Appendix F3, Table 7.

Potential hazard and risk for tribal lifeway exposures to mine discharge were evaluated using the same exposure scenarios (hunting/fishing/gathering and recreational use, potable use, and sweat lodge use) as for surface water (Appendix F3, Tables 3 and 4). Additionally, potential hazards and risks for general public exposures to mine discharge were evaluated using the same exposure scenario (recreational use) and assumptions as the general public wading (dermal only) scenario for surface water (Appendix F3, Tables 5 and 6).

Mine discharge results for Tar Creek and Beaver Creek exceeded acceptable ELCR and HI levels for tribal lifeway but were below acceptable risk levels for the general public. Although Tar Creek mine discharge HI and ELCR estimates were lower than surface water estimates and Beaver Creek mine discharge HI and ELCR estimates were higher than surface water estimates, overall, the results were similar. Therefore, although concentrations (and risk estimates) at mine discharge points were expected to be higher than surface water concentrations (and risk estimates), the results of this comparison indicate otherwise. The potential risks associated with exposures to mine discharge are comparable or even lower than potential risks associated with surface water exposures. Further, it is noted that measured surface water concentrations in the Tar Creek and Beaver Creek watersheds reflect the impacts of mine discharge on surface water.

6.6.2.5 Additional Evaluation for Biota Consumption

An additional evaluation of potential hazard and risk for aquatic biota (animal and plant) ingestion for tribal lifeway receptors was performed (Appendix F4, Table 1) using higher exposure assumptions identified by input from the Quapaw Nation and TCTCIT (2018).

The additional evaluation of potential hazard and risk was performed using the following exposure assumptions:

- Adult aquatic plant ingestion rate of 333 g/day
- Child aquatic biota ingestion rate of 74 percent of the adult ingestion rate

The hazard and risk estimates associated with aquatic biota consumption (as summarized in Table 6-15) are compared to those estimated in this additional evaluation (Appendix F4, Table 1). No carcinogenic final COCs were identified for aquatic biota. Although several additional target organs were identified with unacceptable HIs in the additional evaluation, the overall results were similar to those presented in Table 6-15. Aquatic plant (as food) and shellfish were the only biota categories that exceeded unacceptable hazards in both evaluations.

6.6.2.6 Biota Data Groupings

Potential exposure to COPCs through consumption or medicinal use of biota was evaluated in the HHRA based on the “sitewide” dataset using combined data from all watersheds to account for mobility of tribal lifeway receptors and mobility of animals with an extended home range (e.g., raccoons). As part of this uncertainty analysis, biota-related exposure pathways were evaluated based on watershed-specific biota data (Appendix F5, Tables 1 through 3) to assess potential hazards for tribal lifeway receptors on a watershed by watershed basis.

Fish (estimated whole body eviscerated), shellfish, aquatic plant as food (arrowhead and duckweed), aquatic plant as salve (arrowhead), amphibian/aquatic reptile (frog legs), and semi-aquatic mammal (raccoons) data groups for the final biota COCs (identified in Table 6-12) were created for each of the six watersheds. Note that samples for some biota categories were not available for all watersheds as sampling was limited to the species available at the time of sampling:

- Shellfish tissue data were not available from Tar Creek, Elm Creek, Beaver Creek, and Lost Creek.
- Aquatic plant tissue data (as food) were not available from Beaver Creek.
- Aquatic plant tissue data (as salve) were not available from Neosho River and Beaver Creek.
- Amphibian/aquatic reptile data were not available from Elm Creek.

The ProUCL output used to calculate EPCs for watershed-specific biota datasets is presented in Appendix F5, Tables 4 through 9. Appendix F5, Tables 1 through 3 present HIs for biota-related exposure pathways based on watershed-specific biota datasets and the sitewide dataset.

Noticeable differences in the estimated HI were not observed for fish, shellfish, amphibian/aquatic reptile (frog legs), semi-aquatic mammal (raccoons), and aquatic plant (as salve) between watershed-specific biota datasets and the sitewide dataset. The only incidence where the watershed-specific HI was noticeably greater than the sitewide HI was aquatic plant (as food) in the Elm Creek watershed: the HI is 125 in Elm Creek, whereas the sitewide HI is 91 for the child tribal lifeway scenario.

Also, it should be noted that HIs in Tar Creek, Neosho River, Lost Creek, and Lower Spring River are considerably lower than the sitewide HIs estimated in the HHRA. Therefore, in general, the hazard and risk estimates based on the sitewide dataset in the HHRA were concluded to be an adequate and conservative representation of the estimates based on watershed-specific datasets.

6.6.2.7 Fish Consumption

The potential risk associated with COPC intake through fish consumption was performed based on the estimated "total" concentrations of COPCs in whole fish for tribal lifeway receptors. To provide a practical perspective for those who use different fish body parts in meal preparation, an analysis was performed to evaluate if the estimated "total" concentrations are different from the concentrations in separate body parts (head, fillet, and carcass) and if those who consume a specific body part have higher risk estimates than the estimate based on the "total" concentration in whole fish.

Data

Although various COCs were identified for the biota exposure medium, the total HI associated with exposure to these COCs through fish consumption was less than 1 for both tribal lifeway and general public receptors. Because lead is the primary COC at the Tar Creek Superfund Site, the analysis was performed based on lead data only. To simplify the data analysis, the detected concentrations only were used in this analysis. Among the 80 fish samples included in the data group for the tribal lifeway exposure scenario, 32 samples had no detection of lead in any fish body part; therefore, they were excluded from the dataset. Lead was detected in 40 head, 9 fillet, and 40 carcass samples. For those samples with lead detections, the relative difference in concentration between body part and whole body was calculated for each fish part using the equation below:

$$Relative\ difference = \frac{C_p - C_T}{C_T}$$

Where:

C_p = Lead concentration in a body part (head, fillet, or carcass)
C_T = Estimated "total" lead concentration in whole body

Analysis

Potentially Influential Variables

Various factors may influence the bioaccumulation or partitioning of lead in a fish body. Therefore, the relative difference in lead concentrations was evaluated for the following four variables:

- Fish species (game or non-game species)
- Fish habitat (water column or bottom feeder)
- Fish weight (samples were divided into four groups based on quartile of sample weight):
  - 1st quartile < 56.5 grams (g)
  - 2nd quartile ≥ 56.5 and <110.5 g
  - 3rd quartile ≥ 110.5 and <724.5 g
  - 4th quartile ≥ 724.5 g

- Level of lead exposure; estimated "total" lead concentration in whole fish was used for this variable (samples were divided into four groups based on quartile of estimated "total" lead concentration in whole fish):
  - 1st quartile < 0.29 mg/kg
  - 2nd quartile ≥ 0.29 and < 0.38 mg/kg
  - 3rd quartile ≥ 0.38 and < 0.48 mg/kg
  - 4th quartile ≥ 0.48 mg/kg

To understand the relationship between the categorical variables above, tables presenting the frequency distribution of fish samples were created. As indicated in Appendix F6, Table 1, it was noted that samples of non-game fish species have a tendency for higher body weight and being collected from locations with higher sediment lead concentrations than game fish species. Similarly, bottom feeders have a tendency for higher body weight and were collected from locations with higher sediment lead concentrations than fish inhabiting the water column.

To evaluate if relative differences of lead concentrations vary among the groupings created by the four categories above, a classical "Analysis of Variance" test was performed (Appendix F6, Tables 2 through 4). EPA ProUCL software (Version 5.1.002) (EPA, 2016b) was used for all statistical analysis. No statistically significant differences in relative differences of lead concentrations were observed among the data groupings created by the variables for all three body parts except one. Relative differences in lead concentrations for fish fillet were different between the two data groupings created based on the estimated total "lead" concentration in whole fish[5]. However, regardless of this observed statistically significant difference, all fish fillet samples were used in the analysis because of the small sample size (nine samples were available).

Test of Normality

Using the Shapiro-Wilk test of normality, normality of the data distribution was tested (alpha = 0.05). Quartile-Quartile (Q-Q) plots and the results of normality tests are presented in Appendix F6, Figure 1. Based on the test results, the relative difference of lead concentrations calculated for the three body parts (head, fillet, and carcass) appear to be normally distributed.

Single Sample Hypothesis Test

Single sample hypothesis tests (single sided) were conducted to test if relative difference in lead concentrations was statistically significantly (alpha = 0.05) greater than zero (Appendix F6, Table 5).

The results of the single sample hypothesis test are summarized below.

- Lead concentrations in head of fish are statistically significantly higher than the estimated lead concentrations in whole fish. On average, lead concentrations in head are about 35.6 percent higher than the estimated "total" lead concentrations in whole fish.
- There is no statistically significant increase (alpha = 0.05) in lead concentrations in fish fillet or carcass compared to the estimated "total" lead concentrations in whole fish.

Conclusions

The analysis of detected lead concentrations in fish parts (head, fillet, and carcass) and estimated "total" lead concentrations in whole fish suggest a statistically significantly higher concentration of lead in head than the estimated lead concentration in whole fish. However, no statistically significant increase in lead concentrations was observed in fish fillet or carcass. Therefore, those who eat the head of fish in meals (for example, soup) may experience higher intake of lead than the lead intake based on the estimated "total" lead concentration in whole body in the HHRA.

[5] Because of the small sample counts, the data from the 1st, 2nd, and 3rd quartiles were merged and compared to the 4th quartile dataset.

6.6.2.8 Estimation of Inorganic Arsenic Fraction in Fish Tissue

Arsenic exposures through consumption of fish were evaluated based on the assumption that 10 percent of total arsenic in biota samples is present in a form of inorganic arsenic. As indicated in Section 4.3.5, the broad consensus in the literature suggests that this assumption is reasonable for edible portions of marine fish and shellfish; however, relatively less information is available for the inorganic arsenic fraction in freshwater fish.

Although the results of field studies generally agree with a small fraction of inorganic arsenic (less than 10 percent) observed in marine fish, there are some laboratory-based studies suggesting a higher fraction of inorganic arsenic in freshwater fish (EPA, 1997b). The data from EPA's National Study of Chemical Residues in Lake Fish Tissue (EPA, 2009b) – the first national assessment of freshwater fish contamination in the United States – show a consistent trend of low detection of inorganic arsenic in freshwater fish. Because the study did not analyze fish samples for total arsenic, it is impossible to establish the inorganic arsenic fraction to total arsenic based on these data. However, the data indicate that inorganic arsenic was only detected in a small fraction of samples. Therefore, although field studies generally support the assumption of the small fraction of inorganic arsenic in freshwater fish, consistent with the observation in marine fish used in the HHRA, there is some degree of uncertainty associated with this assumption.

6.6.2.9 Aquatic Plant Parts

Aquatic plant samples (arrowhead and duckweed) were combined to calculate EPCs for plant consumption. Tribal members and citizens may consume different parts of plants (the upper leaf/stem, the tuber, and/or the fine roots of arrowhead). Because concentrations of metals may vary between the different parts of the plants and subsequent metal exposure may depend on patterns of food preparation and consumption of different plant parts, an evaluation of hazard and risks from consumption of separate plant parts (leaf/stem, tuber, fine roots) is performed in Appendix F7.

A comparison of co-located sediment and plant part data for the final biota COCs (identified in Table 6-12[6]) is provided in Appendix F7, Table 1. Concentrations of final COCs in different plant parts were compared and color-coded based on the rank of concentrations. As seen in the table, there was a clear trend of higher concentrations of final COCs in root than leaf, especially when levels of final COCs in sediment are elevated (i.e., greater than their respective BTVs). Elevated concentrations of final COCs are consistent at the co-located sampling point in Elm Creek, Tar Creek, and Lower Spring River, whereas this was not the case for Lost Creek. This observation of higher concentration of metals in root is consistent with the observation in literature (Pullagurala et al., 2018). A sample of tuber was only available from an arrowhead plant collected in Lost Creek. During the course of sampling, from July 2017 to November 2017, the sampling team identified and tracked the status of tubers on the arrowhead plants, but saw little development of this portion of the observed plants. The team delayed collection until the final sampling event to allow the tuber time to grow; however, during the collection, the only specimen that developed a tuber was in Lost Creek. Although it is speculated based on one sample, development of tubers may have something to do with the lower concentrations of final COCs in sediment in Lost Creek compared to those in other watersheds.

Due to the limited number of samples (less than eight), maximum detected concentrations were used as EPCs (see method in Section 4.3.1) to estimate the non-carcinogenic HI, as presented in Appendix F7, Table 2. Roots had the highest estimated HI, followed by leaves. The HIs associated with tubers were below EPA threshold values (a target-organ-specific HI of 1).

[6] No carcinogenic final COCs were identified.

6.6.2.10 Waterfowl

Tribal lifeway and general public receptors may ingest waterfowl caught in the OU5 study area but the risks were not quantified in the HHRA and a discussion of the potential impact on the risk outcome as a result of not including this scenario is discussed here. Waterfowl have a large home range and are expected to be exposed to areas outside the OU5 study area, but when in OU5 study area watersheds may be exposed to metals through ingestion of sediment, surface water, and aquatic biota. Previous investigations show that lead and zinc accumulate in the blood and tissue of waterfowl in the TSMD (van der Merwe, et al., 2011; Beyer et al., 2004). Lead and zinc poisoning has been reported in wild birds in the region (Beyer et al., 2004; Sileo et al., 2004).

As indicated in the Data Gap Evaluation (CH2M, 2017), waterfowl data were not identified during the compilation of existing data. Tribal members and citizens, and members of the general public may hunt and consume waterfowl, but this pathway is not expected to be significant based on TSMD studies that investigated metal tissue concentrations in geese (van der Merwe et al., 2011) and information provided in the Bunker Hill Superfund Site HHRA (TerraGraphics, 2001). Although lead and zinc concentrations were elevated in geese tissue samples collected in the TSMD compared to reference site samples, muscle tissue concentrations from geese (average concentration of lead [0.16 mg/kg] in samples collected in Webb City, Missouri[7]) in these studies were lower than the EPCs for raccoon (0.51 mg/kg) estimated in the HHRA[8]. Because non-carcinogenic HI estimates for the final COCs through consumption of raccoon meat based on an ingestion rate of 69 g/day (roughly equivalent to 4 ounces of meat every other day) were below EPA threshold values (a target-organ-specific HI of 1), risks for waterfowl consumption would not be expected to contribute significantly to sitewide non-carcinogenic hazard estimates.

6.6.2.11 Inhalation of Metals in Water Vapor

Using the method presented in the Shoshone-Bannock risk assessment document (S-B EWMP, 2016), inhalation of COPCs in water vapor (water droplets suspended in air) generated by OU5 study area surface water poured over heated rocks during sweat lodge use was evaluated for tribal lifeway receptors. The equations presented in the Shoshone-Bannock risk assessment calculate air-phase EPCs based on the following assumptions:

- Non-volatile COPCs become airborne as an aerosol as the water they are carried in vaporizes.
- The ideal gas law can be applied to air and water vapor at the temperature and pressure of the sweat lodge.

Based on an assumed sweat lodge temperature of 150 degrees Fahrenheit, or 66 degrees Celsius (S-B EWMP, 2016), a volatilization factor of 0.17 liter of water per cubic meter (L water/m^3) was calculated, and air-phase EPCs were calculated by multiplying surface water EPCs by this volatilization factor.

Although this principle of estimation of COPCs in water vapor during sweat lodge use has been applied in various historical HHRAs with Native American receptor groups (Harris and Harper, 2004; EPA, 2005c; CH2M PRC, 2014), a large degree of uncertainty is associated with the estimated air-phase EPCs calculated using this method.

[7] Canadian geese samples were collected from four areas: Webb City, Missouri; Picher, Oklahoma; and two sites in Galena, Kansas. Lead was not detected in any samples collected in Galena, Kansas (detection limit of 0.024 mg/kg). The average concentration and standard error of concentrations in Webb City, Missouri and Pitcher, Oklahoma are 0.16(±SE 0.16) and 0.03 ((±SE 0.00), respectively.

[8] Sitewide biota consumption for lead is addressed in Appendix E. The addition of waterfowl consumption to the lead evaluation would not change the conclusions.

Because non-volatile contaminants have no vapor pressure, the equations presented in the Shoshone-Bannock risk assessment equations do not have a common physical basis with volatile chemicals. As assumed, it is possible that inhalation of non-volatile COPCs might occur by an alternative physical model, such as respiration of respirable-size aerosols, if such aerosols were formed when water is poured over the hot rocks in a lodge. However, a model of resuspension of non-volatile impurities in aerosol form is inconsistent with other mechanical processes involving steam. For example, EPA does not address this pathway in shower volatilization models (Volatilization Rates from Water to Indoor Air Phase II [EPA, 2000]). It is also inconsistent with the widespread use of steam distillation for commercial water purification. Additionally, compared to EPA's default volatilization factor (0.5 L water/m^3) for various volatile organic compounds during household use of water, the calculated volatilization factor of 0.17 L water/m^3 is expected to highly overestimate concentrations of metals in air.

As presented in Table 6-15, the HI associated with inhalation of water vapor under the sweat lodge scenario is greater than the total HI for the potable use of surface water. In the case of Tar Creek, inhalation of water vapor accounts for more than one-third of the combined HI from all exposure media (sediment, surface water, and biota). Similarly, 100 percent of ELCR from Elm Creek and Beaver Creek and 29 percent of ELCR from Tar Creek were estimated to be associated with inhalation of water vapor under the sweat lodge scenario (Table 6-16). Further, final COCs such as nickel were identified solely based on the hazard/risk estimates associated with inhalation of water vapor under the sweat lodge scenario. Considering that the inhalation hazard/risk estimates under the sweat lodge use scenario are likely to be overestimated, the hazard/risk associated with surface water for tribal lifeway receptors may be considerably less than what was estimated in the HHRA.

SECTION 7

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[9] Note: The Office of Solid Waste and Emergency Response (OSWER) is now the Office of Land and Emergency Management (OLEM)

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Tables

Table 2-1. Demographic Data for the Counties within the TSMD and State of Oklahoma

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Population/Economic Variables	Counties within the TSMD				State of Oklahoma
	Ottawa County Oklahoma	Cherokee County Kansas	Newton County Missouri	Jasper County Missouri	
Total population	31,725	20,501	58,237	118,522	3,896,251
Population/mile^2	67.4	34.9	93.2	185.6	56.8
Area mile^2	471	588	625	638	68,595
No. of households	12,020	7,980	22,151	46,009	1,468,971
Sex (%)					
Male	49.1	49.2	49.7	48.7	49.6
Female	50.9	50.8	50.3	51.3	50.4
Age distribution (%)					
Under 18 years	24.9	24.1	24.3	25.3	24.5
19 to 64 years	57.3	57.9	58.5	60.2	60.8
65 years and over	17.8	18.0	17.2	14.5	14.7
Median age (years old)	38.2	41.4	39.4	35.9	36.3
Race/ethnicity (%)					
One race	87.9	95.0	96.8	97.0	92.2
White	68.3	90.6	90.7	90.4	72.6
African - American	1.1	0.4	1.0	2.2	7.3
American Indian / Alaskan	15.4	3.1	2.4	1.4	7.4
Asian	0.7	0.2	1.3	1.1	2.1
Hawaiian/Pacific Islander	0.7	0.5	0.9	0.1	0.1
Some other race	1.8	0.3	0.5	1.8	2.7
Two or more races	12.1	5.0	3.2	3.0	7.8
Hispanic or Latino (%)	5.4	2.4	5.1	7.7	10.1
Income/poverty					
Median household income ($)	38,472	41,101	46,723	45,328	49,767
Persons below poverty (%)[a]	21.8	13.7	12.9	17.3	16.2

Source: U.S. Census Bureau; 2017 American Community Survey 5-year estimates, 2013-2017.

Notes:

[a] Below federal poverty level

TSMD - Tri-State Mining District

Table 2-2. Watershed-Specific Land Use Descriptions and Designated Beneficial Water Uses

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Watershed	Land Use Descriptions	Designated Beneficial Uses of the Waters within Watershed
Elm Creek	No urban areas Primary land use is cultivated crops and hay/pasture[a]	Aesthetic[b] Agriculture[b] Fish and wildlife propagation (warm water aquatic community)[b] Primary body contact recreation[b]
Tar Creek	Contains many urban areas and historical communities Primary land use is cultivated crops and hay/pasture[a]	Habitat limited aquatic community (HLAC)[c, d] Secondary body contact recreation[c]
Neosho River	Mainly rural, but does contain drainage from the urban area of Miami, Oklahoma Primary land use outside of the developed land is hay/pasture and woody wetlands[a]	Public and private water supply (PPWS)[b, e] Not supporting the warm water aquatic community use due to impairment caused by lead[b] Fish consumption designated use[b]
Beaver Creek	Mainly rural, but does contain drainage from the urban area of Quapaw, Oklahoma Primary land use is hay/pasture[a]	Flows through Quapaw Tribal lands that are historically and culturally significant to the tribe, including the tribe's pow-wow grounds. The creek plays an important part in their cultural and religious practices[f] Assigned default beneficial uses of agriculture, aesthetics, fish and wildlife propagation (warm water aquatic community subcategory), and primary body contact recreation[g]
Lost Creek	Mainly rural, but does contain drainage from the urban areas of Wyandotte, Oklahoma, and Seneca and Racine, Missouri Primary land use outside of the developed land is hay/pasture and mixed forest[a]	PPWS[b, e] Cool water aquatic community fully supported[b] Fish consumption designated use not assessed[b]
Lower Spring River	Mainly rural, but does contain drainage from the urban areas of Baxter Springs and Columbus, Kansas Primary land use in the southern portion of the watershed is hay/pasture and mixed forest[a] Primary land use in the northern portion of the watershed is cultivated crops and hay/pasture[a]	PPWS[b, e] Cool water aquatic community[b] Fish consumption not attained due to impairment caused by lead[b]

Notes:

[a] National Land Cover Database (NLCD), 2011

[b] Oklahoma Department of Environmental Quality (ODEQ), 2018

[c] Oklahoma Water Resources Board (OWRB), 2018a

[d] Based on Oklahoma 2016 303 (d) list of impaired waterbodies HLAC is not attained (ODEQ, 2018)

[e] ODEQ has determined there is either insufficient information to assess the PPWS use-attainment status, or it has not yet been assessed (ODEQ, 2018)

[f] Interstate Technology & Regulatory Council (ITRC), 2013

[g] OWRB, 2018b

Table 3-1. Data Groupings and Associated Receptor/Exposure Scenarios

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Data Grouping	Sample Counts							Exposure Scenario/Receptor Population		
		Sitewide[b]	Watershed[c]								
			Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River	Tribal Lifeway	Aquatic Worker	General Public
Sediment (Rivers and Creeks)	Sediment (0-12 inch deep) (Sieved and Unsieved)	463	41	199	23	38	47	115	Hunting/fishing/gathering and recreational activities • Incidental ingestion • Dermal contact	Work activities • Incidental ingestion • Dermal contact	Recreational activities • Incidental ingestion • Dermal contact
Surface Water (Rivers and Creeks)	Surface Water (Total Metals)	2,207	47	1,396	82	326	69	287	Hunting/fishing/gathering and recreational activities • Incidental ingestion • Dermal contact Potable source • Ingestion • Dermal contact Sweat lodge use • Ingestion • Dermal contact • Inhalation (water vapor)	Work activities • Ingestion • Dermal contact	Recreational activities • Ingestion • Dermal contact Potable source • Ingestion • Dermal contact
Aquatic Biota (Animal and Plant Tissue)[d]	Fish Tissue (Estimated whole fish concentrations[a])	80	22	15	18	4	7	14	• Food consumption		
	Fish Tissue (Game Fish Fillet)	101	24	21	27	3	6	20			Fishing • Food consumption
	Shellfish Tissue (Mussel and Asian Clam)	22	NA	NA	1	NA	NA	21	• Food consumption		
	Aquatic Plant as Food (Arrowhead and Duckweed)	17	3	3	1	NA	8	2	• Food consumption		
	Aquatic Plant as Salve (Arrowhead)[e]	11	2	2	NA	NA	5	2	• Dermal contact (medicinal use)		
	Amphibian/Aquatic Reptile Tissue (Frog Legs)	14	NA	2	4	4	1	3	• Food consumption		
	Semi-Aquatic Mammal Tissue (Raccoon)	19	1	3	6	3	3	3	• Food consumption		

Notes:

[a] Eviscerated whole fish concentration was estimated based on weighted concentrations of three fish body parts (carcass, fillet, and head).

[b] Sitewide data groupings were used for the selection of COPCs for a given data grouping.

[c] After one set of COPCs was selected per data group, EPCs were estimated based on watershed-specific data groupings for sediment and surface water. Mine discharge is evaluated in Appendix F.

[d] For aquatic biota (animal and plant tissue), EPCs were estimated based on sitewide data groupings to account for movement of animals and receptors.

[e] Whole arrowhead plant (sitewide) was used to estimate EPCs.

COPC = chemical of potential concern

EPC = exposure point concentration

HHRA = human health risk assessment

NA = not available

Table 3-2. Summary of Chemicals of Potential Concern

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

	Exposure Medium	Sediment (Rivers and Creeks)		Surface Water (Rivers and Creeks)		Aquatic Biota (Animal and Plant Tissue)[e]						
	Data Grouping[a]	Sediment (0-12 inch deep) (Sieved and Unsieved)		Surface Water (Total Metals)[a]		Fish Tissue (Estimated Whole Fish Concentrations)	Fish Tissue (Game Fish Fillet)	Shellfish Tissue (Mussel and Asian Clam)	Aquatic Plant as Food (Arrowhead and Duckweed)	Aquatic Plant as Salve (Arrowhead)	Amphibian/ Aquatic Reptile Tissue (Frog Legs)	Semi-Aquatic Mammal Tissue (Raccoon)
	Receptor Population	[TLW/AW][c]	[GP][d]	[TLW/AW][c]	[GP][d]	[TLW][c,e]	[GP][e]	[TLW][c,e]	[TLW][c,e]	[TLW][c]	[TLW][c,e]	[TLW][c,e]
	RAGS Table No.	Table 2.1a	Table 2.1b	Table 2.2a	Table 2.2b	Table 2.3	Table 2.4	Table 2.5	Table 2.6	Table 2.7	Table 2.8	Table 2.9
CAS	Analyte[b]											
7429-90-5	Aluminum	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7440-36-0	Antimony	YES	YES	YES	YES	YES	YES	n/d	YES	YES	n/d	YES
7440-38-2	Arsenic	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7440-39-3	Barium	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
7440-41-7	Beryllium	YES	NO	YES	NO	YES	YES	YES	YES	YES	YES	YES
7440-42-8	Boron	YES	NO	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7440-43-9	Cadmium	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7440-47-3	Chromium	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7440-48-4	Cobalt	YES	YES	YES	YES	YES	YES	YES	YES	YES	n/d	n/d
7440-50-8	Copper	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7439-89-6	Iron	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7439-92-1	Lead	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7439-93-2	Lithium	YES	YES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7439-96-5	Manganese	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7439-97-6	Mercury	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7439-98-7	Molybdenum	YES	YES	YES	YES	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7440-02-0	Nickel	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
7723-14-0	Phosphorus	YES	YES	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7782-49-2	Selenium	YES	YES	YES	NO	YES	YES	YES	n/d	n/d	YES	YES
7631-86-9	Silica (as SIO2)	YES	NO	YES	NO	n/a	n/a	YES	n/a	n/a	n/a	n/a
7440-22-4	Silver	YES	NO	YES	NO	YES	YES	YES	YES	n/d	YES	n/d
7440-24-6	Strontium	YES	NO	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7440-28-0	Thallium	YES	YES	YES	YES	YES	YES	n/d	n/d	n/d	YES	YES
7440-62-2	Vanadium	YES	YES	YES	YES	YES	n/d	n/d	YES	YES	n/d	n/d
7440-66-6	Zinc	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes:

[a] Identification of COPCs was performed on sitewide data of a given exposure medium (sediment, surface water, and each animal/plant tissue data group).
A summary of exposure scenarios/receptor populations for which each data grouping was evaluated is provided in Table 3-1.
Surface water data grouping was evaluated for three exposure scenarios (hunting/fishing/gathering/recreational, potable use, sweat lodge use) for TLW and two exposure scenarios (recreational and potable use) for GP.

[b] Analytes identified as a COPC in at least one data group are presented in this table.
Essential nutrients (calcium, magnesium, potassium, sodium) and analytes with no toxicity information (titanium) were not identified as COPCs in any data groups.

c Because of the lack of readily available screening values for TLW/AW scenarios and their elevated exposure intensity, frequency, and duration more than the EPA's default residential scenario, all the detected analytes (excluding essential nutrients and analytes with no toxicity information) were identified as COPCs.

[d] For the GP scenario, the maximum detected concentrations of the analytes exceeding applicable EPA RSLs were identified as COPCs.
Residential soil and tap water RSLs were used conservatively to identify COPCs in sediment and surface water (recreational scenario).

[e] Because of the lack of readily available screening values for food consumption scenarios, all the detected analytes (excluding essential nutrients and analytes with no toxicity information) were identified as COPCs.

Identification of COPCs:

YES – Analyte was identified as a COPC
TLW/AW – Analyte was identified as COPC because it was detected in at least one sample within the data group.
GP – Analyte was identified as COPC because it was detected in at least one sample within the data group and the maximum detected concentration exceeds applicable EPA RSL.
TLW/AW/GP (Aquatic Animal and Plant Tissue) – Analyte was identified as COPC because it was detected in at least one sample within the data group.

NO, n/d, n/a – Analyte was not identified as a COPC
NO – Analyte was not identified as a COPC because the maximum detected concentration does not exceed applicable EPA RSL.
n/d – Analyte was analyzed but not detected in any samples within the data group.
n/a – not analyzed

Receptor Populations:
AW = aquatic worker receptors
GP = general public receptors
TLW = tribal lifeway receptors

Acronyms:
CAS = Chemical Abstracts Service
COPC = chemical of potential concern
EPA = U.S. Environmental Protection Agency
RAGS = Risk Assessment Guidance for Superfund
RSL = Regional Screening Level

Table 6-1. Summary of Receptor Hazards and Selection of Preliminary Chemicals of Concern - Tribal Lifeway Child [a]

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 9.2.RME)	Tar Creek (TABLE 9.9.RME)	Neosho River (TABLE 9.16.RME)	Beaver Creek (TABLE 9.23.RME)	Lost Creek (TABLE 9.30.RME)	Lower Spring River (TABLE 9.37.RME)
Non-Carcinogenic Hazard Index								
Sediment (Rivers & Creeks)	Hunting, Fishing, Gathering and Recreational Activities	Ingestion	15	24	9	13	5	8
		Dermal	0.2	0.7	0.04	0.3	0.04	0.1
	Total (Sediment)		16	25	9	13	5	9
	Target Organ-Specific Total HI [b]	Cardiovascular	≤ 1	2	≤ 1	≤ 1	≤ 1	≤ 1
		Dermal	≤ 1	3	≤ 1	≤ 1	≤ 1	≤ 1
		Endocrine	≤ 1	3	6	2	≤ 1	2
		Gastrointestinal	≤ 1	3	≤ 1	≤ 1	≤ 1	2
		Hematologic	9	6	≤ 1	2	≤ 1	≤ 1
		Immune	8	2	≤ 1	2	≤ 1	≤ 1
		Nervous	≤ 1	≤ 1	≤ 1	2	3	≤ 1
		Urinary	3	9	≤ 1	4	≤ 1	≤ 1
		Whole Body	≤ 1	4	≤ 1	≤ 1	≤ 1	≤ 1
	Preliminary Sediment COCs [c]		Antimony	Antimony	Cobalt	Aluminum	Aluminum	Cobalt
			Cadmium	Arsenic	Lead	Antimony	Lead	Iron
			Lead	Cadmium		Cadmium	Manganese	Lead
			Zinc	Cobalt		Cobalt		
				Iron		Lead		
				Lead		Manganese		
				Molybdenum		Molybdenum		
				Vanadium		Zinc		
				Zinc				
Surface Water (Rivers & Creeks)	Hunting, Fishing, Gathering and Recreational Activities	Ingestion	5	13	2	2	0.2	1
		Dermal	4	5	1	0.8	0.2	0.7
		Total	9	18	3	3	0.5	2
	Potable Use	Ingestion	9	23	3	4	0.4	2
		Dermal	0.6	0.7	0.1	0.1	0.03	0.1
		Total	10	23	3	4	0.4	2
	Sweat Lodge	Ingestion	12	29	4	5	0.5	2
		Dermal	1	1	0.3	0.2	0.06	0.2
		Inhalation	134	318	65	53	18	40
		Total	146	348	69	58	19	42
	Total (Surface Water)		165	390	76	66	20	46
	Target Organ-Specific Total HI [b]	Cardiovascular	3	33	4	8	NA	≤ 1
		Dermal	3	33	4	9	≤ 1	≤ 1
		Developmental	2	16	4	5	≤ 1	2
		Endocrine	4	16	2	4	NA	≤ 1
		Gastrointestinal	≤ 1	11	2	≤ 1	≤ 1	≤ 1
		Hematologic	4	3	≤ 1	≤ 1	≤ 1	≤ 1
		Immune	3	3	≤ 1	≤ 1	≤ 1	≤ 1
		Musculoskeletal	NA	NA	52	NA	NA	NA
		Nervous	99	254	52	39	18	34
		Not specified	≤ 1	≤ 1	2	≤ 1	NA	≤ 1
		Reproductive	≤ 1	16	2	4	NA	≤ 1
		Respiratory	14	82	16	17	≤ 1	6
		Urinary	42	18	≤ 1	2	≤ 1	2
		Whole Body	≤ 1	3	≤ 1	≤ 1	≤ 1	≤ 1
	Preliminary Surface Water COCs [c]		Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum
			Antimony	Arsenic	Arsenic	Arsenic	Lead	Arsenic
			Arsenic	Barium	Barium	Barium	Manganese	Barium
			Barium	Cadmium	Chromium	Cadmium		Cadmium
			Cadmium	Chromium	Cobalt	Chromium		Chromium
			Chromium	Cobalt	Iron	Cobalt		Cobalt
			Cobalt	Iron	Lead	Lead		Lead
			Lead	Lead	Manganese	Manganese		Manganese
			Manganese	Manganese	Nickel	Nickel		Nickel
			Nickel	Nickel	Vanadium	Vanadium		Vanadium
			Vanadium	Vanadium				
			Zinc	Zinc				

Table 6-1. Summary of Receptor Hazards and Selection of Preliminary Chemicals of Concern - Tribal Lifeway Child [a]

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 9.2.RME)	Tar Creek (TABLE 9.9.RME)	Neosho River (TABLE 9.16.RME)	Beaver Creek (TABLE 9.23.RME)	Lost Creek (TABLE 9.30.RME)	Lower Spring River (TABLE 9.37.RME)
Aquatic Animal/Plant	Fish	Ingestion	5	See Note [d]				
	Shellfish	Ingestion	16					
	Aquatic Plant (food)	Ingestion	206					
	Aquatic Plant (salve)	Dermal	0.01					
	Amphibian/Aquatic Reptile	Ingestion	0.6					
	Semi-Aquatic Mammal	Ingestion	5					
	Total (Biota)		233					
	Target Organ-Specific Total HI [b]	Cardiovascular	5					
		Dermal	10					
		Developmental	5					
		Endocrine	56					
		Gastrointestinal	42					
		Hematologic	34					
		Immune	24					
		Nervous	28					
		Urinary	68					
		Whole Body	8					
	Preliminary Biota COCs [c]		Aluminum					
			Antimony					
			Arsenic					
			Barium					
			Beryllium					
			Cadmium					
			Cobalt					
			Copper					
			Iron					
			Lead					
			Manganese					
			Mercury					
			Nickel					
			Selenium					
			Silver					
			Vanadium					
			Zinc					
Total (Receptor) [c]			414	648	318	312	258	287

Notes:

[a] Because the child tribal lifeway exposure scenario yields higher non-carcinogenic hazard estimates than the adult exposure scenario, the preliminary COCs for non-carcinogenic endpoints were identified based on the child tribal lifeway exposure scenario.

[b] The target organ-specific total HI is presented for the target organs or target systems whose total HI is greater than 1 in at least one watershed.

[c] When a target organ-specific total HI of 1 is exceeded for an exposure medium (i.e., sediment, surface water, or biota), the COPCs posing an HQ greater than 0.1 for that target organ in the environmental medium responsible for the unacceptable HI are identified as preliminary COCs.

The evaluation of lead exposure was performed in Appendix E. The evaluation of mine discharge was performed in Appendix F.

[d] The non-carcinogenic HI associated with aquatic animal/plant was calculated based on a sitewide dataset. The sitewide non-carcinogenic HI presented under Elm Creek is applicable to all six watersheds for estimating total non-carcinogenic HI for the receptor.

COC = chemical of concern

COPC = chemical of potential concern

HHRA = human health risk assessment

HI = hazard index

HQ = hazard quotient

NA = not available

RME = reasonable maximum exposure

Table 6-2. Summary of Receptor Excess Lifetime Cancer Risks and Selection of Preliminary Chemicals of Concern - Tribal Lifeway Adult/Child Aggregate

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 9.3.RME)	Tar Creek (TABLE 9.10.RME)	Neosho River (TABLE 9.17.RME)	Beaver Creek (TABLE 9.24.RME)	Lost Creek (TABLE 9.31.RME)	Lower Spring River (TABLE 9.38.RME)
Excess Lifetime Cancer Risk								
Sediment (Rivers & Creeks)	Hunting, Fishing, Gathering and Recreational Activities	Ingestion	7.E-05	3.E-04	6.E-05	1.E-04	3.E-05	9.E-05
		Dermal	1.E-05	5.E-05	1.E-05	3.E-05	5.E-06	2.E-05
	Total (Sediment)		8.E-05	3.E-04	7.E-05	2.E-04	3.E-05	1.E-04
	Preliminary Sediment COCs [a]		None	Arsenic	None	Arsenic	None	None
Surface Water (Rivers & Creeks)	Hunting, Fishing, Gathering and Recreational Activities	Ingestion	7.E-05	5.E-04	1.E-04	1.E-04	NA	3.E-05
		Dermal	2.E-04	3.E-04	6.E-04	2.E-04	NA	1.E-04
		Total	2.E-04	8.E-04	7.E-04	4.E-04	NA	2.E-04
	Potable Use	Ingestion	2.E-04	2.E-03	4.E-04	5.E-04	NA	1.E-04
		Dermal	3.E-05	4.E-05	8.E-05	3.E-05	NA	2.E-05
		Total	3.E-04	2.E-03	5.E-04	6.E-04	NA	1.E-04
	Sweat Lodge	Ingestion	1.E-04	9.E-04	2.E-04	2.E-04	NA	5.E-05
		Dermal	3.E-05	5.E-05	9.E-05	3.E-05	NA	2.E-05
		Inhalation	2.E-03	5.E-03	4.E-03	2.E-03	4.E-06	1.E-03
		Total	2.E-03	6.E-03	5.E-03	2.E-03	4.E-06	1.E-03
	Total (Surface Water)		3.E-03	9.E-03	6.E-03	3.E-03	4.E-06	2.E-03
	Preliminary Surface Water COCs [a]		Arsenic	Arsenic	Arsenic	Arsenic	None	Arsenic
			Cadmium	Beryllium	Cadmium	Cadmium		Cadmium
			Chromium	Cadmium	Chromium	Chromium		Chromium
			Cobalt	Chromium	Cobalt	Cobalt		Cobalt
			Nickel	Cobalt	Nickel	Nickel		Nickel
				Nickel				
Aquatic Animal/Plant	Fish	Ingestion	7.E-05					
	Shellfish	Ingestion	4.E-04		See Note [b]			
	Aquatic Plant (food)	Ingestion	5.E-04					
	Aquatic Plant (salve)	Dermal	3.E-07					
	Amphibian/Aquatic Reptile	Ingestion	3.E-05					
	Semi-Aquatic Mammal	Ingestion	6.E-05					
	Total (Biota)		1.E-03					
	Preliminary Biota COCs [a]		Arsenic					
Total (Receptor) [b]			4.E-03	1.E-02	7.E-03	5.E-03	1.E-03	3.E-03

Notes:

[a] When an ELCR of $1x10^{-4}$ is exceeded for an exposure medium (i.e., sediment, surface water, or biota), the COPCs posing an ELCR greater than $1x10^{-6}$ in the environmental medium responsible for the unacceptable ELCR are identified as preliminary COCs.

The lists of preliminary COCs in this table do not include lead. The evaluation of lead exposure was performed in Appendix E. The evaluation of mine discharge was performed in Appendix F.

[b] ELCR associated with aquatic animal/plant was calculated based on sitewide dataset. The sitewide ELCR presented under Elm Creek is applicable to all six watersheds for estimating total ELCR for the receptor.

COC = chemical of concern

COPC = chemical of potential concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

NA = not available

RME = reasonable maximum exposure

Table 6-3. Summary of Receptor Hazards and Excess Lifetime Cancer Risks and Selection of Preliminary Chemicals of Concern - Aquatic Worker

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 9.4.RME)	Tar Creek (TABLE 9.11.RME)	Neosho River (TABLE 9.18.RME)	Beaver Creek (TABLE 9.25.RME)	Lost Creek (TABLE 9.32.RME)	Lower Spring River (TABLE 9.39.RME)
Non-Carcinogenic Hazard Index								
Sediment (Rivers & Creeks)	Work Activities	Ingestion	3	4	2	2	0.9	1
		Dermal	0.1	0.4	0.02	0.2	0.02	0.06
	Total (Sediment)		3	5	2	2	0.9	2
	Target Organ-Specific Total HI [a]	Urinary	≤ 1	2	≤ 1	≤ 1	≤ 1	≤ 1
	Preliminary Sediment COCs [b,d]		Lead	Cadmium	None	None	None	None
				Lead				
Surface Water (Rivers & Creeks)	Work Activities	Ingestion	0.9	2	0.3	0.4	0.04	0.2
		Dermal	3	3	0.7	0.6	0.2	0.5
	Total (Surface Water)		4	6	1	1	0.2	1
	Target Organ-Specific Total HI [a]	Nervous	≤ 1	3	≤ 1	≤ 1	≤ 1	≤ 1
		Respiratory	≤ 1	2	≤ 1	≤ 1	≤ 1	≤ 1
		Urinary	2	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1
	Preliminary Surface Water COCs [b,d]		Cadmium	Arsenic	None	None	None	None
				Chromium				
				Cobalt				
				Manganese				
				Nickel				
Total (Receptor)			6	10	3	3	1	2
Excess Lifetime Cancer Risk								
Sediment (Rivers & Creeks)	Work Activities	Ingestion	1.E-05	6.E-05	1.E-05	3.E-05	6.E-06	2.E-05
		Dermal	1.E-05	5.E-05	1.E-05	3.E-05	5.E-06	2.E-05
	Total (Sediment)		3.E-05	1.E-04	2.E-05	6.E-05	1.E-05	4.E-05
	Preliminary Sediment COCs [c,d]		No preliminary COCs were identified for carcinogenic endpoints in sediment.					
Surface Water (Rivers & Creeks)	Work Activities	Ingestion	1.E-05	1.E-04	2.E-05	3.E-05	NA	5.E-06
		Dermal	5.E-05	8.E-05	2.E-04	6.E-05	NA	4.E-05
	Total (Surface Water)		6.E-05	2.E-04	2.E-04	9.E-05	NA	4.E-05
	Preliminary Surface Water COCs [c,d]		None	Arsenic	Arsenic	None	None	None
				Chromium	Chromium			
Total (Receptor)			9.E-05	3.E-04	2.E-04	1.E-04	1.E-05	8.E-05

Notes:

[a] The target organ-specific total HI is presented for the target organs or target systems whose total HI is greater than 1 in at least one watershed.

[b] When a target organ-specific total HI of 1 is exceeded for an exposure medium (i.e., sediment or surface water), the COPCs posing an HQ greater than 0.1 for that target organ in the environmental medium responsible for the unacceptable HI are identified as preliminary COCs.

[c] When an ELCR of $1x10^{-4}$ is exceeded for an exposure medium (i.e., sediment or surface water), the COPCs posing an ELCR greater than $1x10^{-6}$ in the environmental medium responsible for the unacceptable ELCR are identified as preliminary COCs.

[d] Lead in surface water was not evaluated for aquatic workers because of the limitations of the ALM. The evaluation of lead exposure was performed in Appendix E.

ALM = Adult Lead Methodology

COC = chemical of concern

COPC = chemical of potential concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

HI = hazard index

HQ = hazard quotient

NA = not available

RME = reasonable maximum exposure

Table 6-4. Summary of Receptor Hazards and Selection of Preliminary Chemicals of Concern - General Public Child [a]

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 9.6.RME)	Tar Creek (TABLE 9.13.RME)	Neosho River (TABLE 9.20.RME)	Beaver Creek (TABLE 9.27.RME)	Lost Creek (TABLE 9.34.RME)	Lower Spring River (TABLE 9.41.RME)
Non-Carcinogenic Hazard Index								
Sediment (Rivers & Creeks)	Recreational Activities	Ingestion	0.7	1	0.4	0.6	0.2	0.4
		Dermal	0.01	0.05	0.003	0.02	0.003	0.008
	Total (Sediment)		0.7	1	0.4	0.6	0.2	0.4
	Preliminary Sediment COCs [c]		Lead	Lead	None	Lead	None	Lead
Surface Water (Rivers & Creeks)	Recreational Activities	Ingestion	0.1	0.3	0.04	0.05	0.005	0.02
		Dermal	0.08	0.09	0.02	0.02	0.005	0.01
		Total	0.2	0.4	0.06	0.06	0.009	0.03
	Potable Use	Ingestion	9	22	3	4	0.4	2
		Dermal	0.5	0.6	0.1	0.1	0.03	0.09
		Total	9	22	3	4	0.4	2
	Total (Surface Water)		9	23	3	4	0.4	2
	Target Organ-Specific Total HI [b]	Cardiovascular	≤ 1	6	≤ 1	≤ 1	NA	≤ 1
		Dermal	≤ 1	6	≤ 1	2	≤ 1	≤ 1
		Endocrine	≤ 1	5	≤ 1	≤ 1	NA	≤ 1
		Gastrointestinal	≤ 1	4	≤ 1	≤ 1	≤ 1	≤ 1
		Nervous	2	4	≤ 1	≤ 1	≤ 1	≤ 1
		Urinary	4	2	≤ 1	≤ 1	≤ 1	≤ 1
	Preliminary Surface Water COCs [c]		Cadmium	Arsenic	None	Arsenic	None	Lead
			Lead	Cadmium		Lead		
			Manganese	Cobalt				
				Iron				
				Lead				
				Manganese				
Aquatic Animal	Fish	Ingestion	4	See Note [d]				
	Target Organ-Specific Total HI [b]	Hematologic	2					
		Nervous	2					
	Preliminary Fish COCs [c]		Antimony					
			Lead					
			Mercury					
			Selenium					
Total (Receptor)			14	28	8	9	5	6

Notes:

[a] Because the child exposure scenario yields higher non-carcinogenic hazard estimates than the adult exposure scenario, the preliminary COCs for non-carcinogenic endpoints were identified based on the child exposure scenario.

[b] The target organ-specific total HI is presented for the target organs or target systems whose total HI is greater than 1 in at least one watershed.

[c] When a target organ-specific total HI of 1 is exceeded for an exposure medium (i.e., sediment, surface water, or fish), the COPCs posing an HQ greater than 0.1 for that target organ in the environmental medium responsible for the unacceptable HI are identified as preliminary COCs.

The evaluation of lead exposure was performed in Appendix E. The evaluation of mine discharge was performed in Appendix F.

[d] Non-carcinogenic HI associated with fish consumption was calculated based on sitewide dataset. The sitewide non-carcinogenic HI presented under Elm Creek is applicable to all six watersheds for estimating total non-carcinogenic HI for the receptor.

COC = chemical of concern

COPC = chemical of potential concern

HHRA = human health risk assessment

HI = hazard index

HQ = hazard quotient

NA = not available

RME = reasonable maximum exposure

Table 6-5. Summary of Receptor Excess Lifetime Cancer Risks and Selection of Preliminary Chemicals of Concern - General Public Adult/Child Aggregate

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 9.7.RME)	Tar Creek (TABLE 9.14.RME)	Neosho River (TABLE 9.21.RME)	Beaver Creek (TABLE 9.28.RME)	Lost Creek (TABLE 9.35.RME)	Lower Spring River (TABLE 9.42.RME)
Excess Lifetime Cancer Risk								
Sediment (Rivers & Creeks)	Recreational Activities	Ingestion	1.E-06	5.E-06	1.E-06	3.E-06	5.E-07	2.E-06
		Dermal	2.E-07	7.E-07	1.E-07	4.E-07	7.E-08	2.E-07
	Total (Sediment)		1.E-06	5.E-06	1.E-06	3.E-06	5.E-07	2.E-06
	Preliminary Sediment COCs [a]		No preliminary COCs were identified for carcinogenic endpoints in sediment.					
Surface Water (Rivers & Creeks)	Recreational Activities	Ingestion	8.E-07	5.E-06	2.E-06	2.E-06	NA	5.E-07
		Dermal	3.E-06	4.E-06	9.E-06	3.E-06	NA	2.E-06
		Total	4.E-06	9.E-06	1.E-05	5.E-06	NA	3.E-06
	Potable Use	Ingestion	1.E-04	7.E-04	3.E-04	2.E-04	NA	6.E-05
		Dermal	2.E-05	3.E-05	7.E-05	3.E-05	NA	2.E-05
		Total	1.E-04	8.E-04	3.E-04	3.E-04	NA	8.E-05
	Total (Surface Water)		1.E-04	8.E-04	3.E-04	3.E-04	NA	9.E-05
	Preliminary Surface Water COCs [a]		None	Arsenic	Arsenic	Arsenic	None	None
				Chromium	Chromium	Chromium		
Aquatic Animal	Fish	Ingestion	2.E-05	See Note [b]				
	Preliminary Fish COCs [a]		No preliminary COCs were identified for carcinogenic endpoints in fish.					
Total (Receptor)			2.E-04	8.E-04	4.E-04	3.E-04	2.E-05	1.E-04

Notes:

[a] When an ELCR of $1x10^{-4}$ is exceeded for an exposure medium (i.e., sediment, surface water, or fish), the COPCs posing an ELCR greater than $1x10^{-6}$ in the environmental medium responsible for the unacceptable ELCR are identified as preliminary COCs.

The lists of preliminary COCs in this table do not include lead. The evaluation of lead exposure was performed in Appendix E. The evaluation of mine discharge was performed in Appendix F.

[b] ELCR associated with fish consumption was calculated based on sitewide dataset. The sitewide ELCR presented under Elm Creek is applicable to all six watersheds for estimating total ELCR for the receptor.

COC = chemical of concern

COPC = chemical of potential concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

HI = hazard index

NA = not available

RME = reasonable maximum exposure

Table 6-6. Final Sediment COCs for Tar Creek OU5 (Tribal Lifeway - Sediment)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Elm Creek		Tar Creek		Neosho River		Beaver Creek		Lost Creek		Lower Spring River	
Preliminary COC [a,b]	**Exceeds Bkgd? [c]**	**Preliminary COC [a,b]**	**Exceeds Bkgd? [c]**	**Preliminary COC [a,b]**	**Exceeds Bkgd? [c]**	**Preliminary COC [a,b]**	**Exceeds Bkgd? [c]**	**Preliminary COC [a,b]**	**Exceeds Bkgd? [c]**	**Preliminary COC [a,b]**	**Exceeds Bkgd? [c]**
						Aluminum	No (s/us)	Aluminum	No (us)		
Antimony	No (us)	Antimony	No (s/us)			Antimony	No (s/us)				
		Arsenic	No (s/us)			Arsenic	No (s/us)				
Cadmium	Yes (s/us)	Cadmium	Yes (s/us)			Cadmium	Yes (s/us)				
		Cobalt	No (s/us)	Cobalt	No (us)	Cobalt	No (s/us)			Cobalt	No (s/us)
		Iron	No (s/us)							Iron	No (s/us)
Lead	Yes (s/us)	Lead	Yes (s/us)	Lead	No (s/us)	Lead	Yes (s/us)	Lead	No (s/us)	Lead	Yes (s/us)
						Manganese	No (s/us)	Manganese	No (us)		
		Molybdenum	Yes (s)			Molybdenum	Yes (s)				
		Vanadium	No (us)								
Zinc	Yes (s/us)	Zinc	Yes (s/us)			Zinc	Yes (us)				

Notes:

[a] Preliminary sediment COCs were identified for direct exposure (ingestion and dermal contact) through hunting, fishing, gathering, and recreational activities based on hazard estimates for child receptor and ELCR estimates for adult/child aggregate receptor (Tables 6-1 and 6-2).

[b] The evaluation of lead exposure was performed in Appendix E.

[c] Results of background comparisons are presented as follows:

Yes (s/us)	site > bkgd based on both sieved and unsieved data
Yes (s)	site > bkgd based on sieved data only (unsieved data are not available)
No (s/us)	no statistical difference between site and bkgd based on both sieved and unsieved data
No (us)	no statistical difference between site and bkgd based on unsieved data only (sieved data are not available)

Refinement of the preliminary COCs:

To identify the final COCs, the lists of preliminary COCs were refined using a two-step process (see decision flow chart on Figure 6-1):

1. Background comparison, and 2. Nature of mine-related contamination.

1. Background Comparison:

When statistical background comparison (central tendency) indicates concentrations in site sediment are not greater than background (site < bkgd), that preliminary COC was eliminated as a final COC. Statistical background comparisons are presented in Section 6 tables of the RI report. When the background comparison indicates site > bkgd, then further review of that preliminary COC was performed based on nature of mine-related contamination. When the background comparisons were performed on both sieved and unsieved datasets, if at least one of the datasets indicates site > bkgd, the preliminary COC was conservatively retained for further evaluation.

2. Nature of Mine-Related Contamination:

For those preliminary COCs that were not eliminated based on background comparisons, further review of that preliminary COC was performed based on nature of mine-related contamination. Literature review was performed to evaluate likeliness of preliminary COC being associated with TSMD ore bodies (Table 7-1 of the RI report). If preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was eliminated as a final COC.

Based on the literature review, it was concluded that molybdenum is not likely to be associated with TSMD ore bodies; therefore, it was excluded as a final COC.

Final COC.

Bkgd = background

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

OU5 = Operable Unit 5

RI = remedial investigation

TSMD = Tri-State Mining District

Table 6-7. Final Sediment COCs for Tar Creek OU5 (Aquatic Worker - Sediment)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Elm Creek [a]		Tar Creek		Neosho River [a]		Beaver Creek [a]		Lost Creek [a]		Lower Spring River [a]	
Preliminary COC [b,c]	Exceeds Bkgd? [d]	Preliminary COC [b,c]	Exceeds Bkgd? [d]	Preliminary COC [b,c]	Exceeds Bkgd? [d]	Preliminary COC [b,c]	Exceeds Bkgd? [d]	Preliminary COC [b,c]	Exceeds Bkgd? [d]	Preliminary COC [b,c]	Exceeds Bkgd? [d]
None		Cadmium	Yes (s/us)	None		None		None		None	
Lead	Yes (s/us)	Lead	Yes (s/us)	None		None		None		None	

Notes:

[a] No preliminary COCs were identified for Elm Creek, Neosho River, Beaver Creek, Lost Creek, and Lower Spring River.

[b] Preliminary sediment COCs were identified for direct exposure (ingestion and dermal contact) through work activities (Table 6-3).

[c] The evaluation of lead exposure was performed in Appendix E.

[d] Results of background comparisons are presented as follow:

Yes (s/us) site > bkgd based on both sieved and unsieved data

Refinement of the preliminary COCs:

To identify the final COCs, the lists of preliminary COCs were refined using a two-step process (see decision flow chart on Figure 6-1):

1. Background comparison, and 2. Nature of mine-related contamination.

1. Background Comparison:

When statistical background comparison (central tendency) indicates concentrations in site sediment are not greater than background (site < bkgd), that preliminary COC was eliminated as a final COC. Statistical background comparisons are presented in Section 6 tables of the RI report. When the background comparison indicates site > bkgd, then further review of that preliminary COC was performed based on nature of mine-related contamination. When the background comparisons were performed on both sieved and unsieved datasets, if at least one of the datasets indicates site > bkgd, the preliminary COC was con fr

2. Nature of Mine-Related Contamination:

For those preliminary COCs that were not eliminated based on background comparisons, further review of that preliminary COC was performed based on nature of mine-related contamination. Literature review was performed to evaluate likeliness of preliminary COC being associated with TSMD ore bodies (Table 7-1 of RI report). If preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was eliminated as a final COC.

No preliminary COC was eliminated based on nature of mine-related contamination.

Final COC.

Bkgd = background

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

OU5 = Operable Unit 5

RI = remedial investigation

TSMD = Tri-State Mining District

Table 6-8. Final COCs for Tar Creek OU5 (General Public - Sediment)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Elm Creek		Tar Creek		Neosho River		Beaver Creek		Lost Creek		Lower Spring River	
Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]
Lead	Yes (s/us)	Lead	Yes (s/us)	None		Lead	Yes (s/us)	None		Lead	Yes (s/us)

Notes:

[a] No preliminary sediment COCs were identified for direct exposure (ingestion and dermal contact) through recreational activities based on hazard estimates for child receptor and ELCR estimates for adult/child aggregate receptor (Tables 6-4 and 6-5).

[b] The evaluation of lead exposure was performed in Appendix E.

[c] Results of background comparisons are presented as follow:

Yes (s/us) site > bkgd based on both sieved and unsieved data

Final COC.

Bkgd = background

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

OU5 = Operable Unit 5

TSMD = Tri-State Mining District

Table 6-9. Final Surface Water COCs for Tar Creek OU5 (Tribal Lifeway - Surface Water)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Elm Creek		Tar Creek		Neosho River		Beaver Creek		Lost Creek		Lower Spring River	
Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]	Preliminary COC [a,b]	Exceeds Bkgd? [c]
Aluminum	No	Aluminum	No	Aluminum	Yes	Aluminum	No	Aluminum	No	Aluminum	Yes
Antimony	Yes										
Arsenic	No	Arsenic	Yes	Arsenic	No	Arsenic	No			Arsenic	No
Barium	No	Barium	No	Barium	Yes	Barium	No			Barium	No
		Beryllium	No [d]								
Cadmium	Yes	Cadmium	Yes	Cadmium	No	Cadmium	Yes			Cadmium	No
Chromium	No	Chromium	Yes	Chromium	No	Chromium	No			Chromium	No
Cobalt	No	Cobalt	Yes	Cobalt	No	Cobalt	Yes			Cobalt	No
		Iron	Yes	Iron	Yes						
Lead	Yes	Lead	Yes	Lead	No	Lead	Yes	Lead	No	Lead	No
Manganese	No	Manganese	Yes	Manganese	No	Manganese	No	Manganese	No	Manganese	No
Nickel	Yes	Nickel	Yes	Nickel	No	Nickel	Yes			Nickel	No
Vanadium	No	Vanadium	Yes	Vanadium	No	Vanadium	No			Vanadium	No
Zinc	Yes	Zinc	Yes								

Notes:

[a] Preliminary surface water COCs were identified for three direct exposure (ingestion and dermal contact) scenarios combined (hunting, fishing, gathering and recreational activities; potable use; sweat lodge use) based on hazard estimates for child receptor and ELCR estimates for adult/child aggregate receptor (Tables 6-1 and 6-2).

[b] The evaluation of lead exposure was performed in Appendix E.

[c] Results of background comparisons are presented as follows:

Yes	site > bkgd; statistically significant increase in site concentrations above background
No	no statistical difference between site and background

[d] No background comparison was performed due to low frequency of detection (2/198 samples). Maximum detected concentrations were lower than the UTL95-95; therefore beryllium was eliminated as final COC.

Refinement of the preliminary COCs:

To identify the final COCs, the lists of preliminary COCs were refined using a two-step process (see decision flow chart on Figure 6-1):

1. Background comparison, and 2. Nature of mine-related contamination.

1. Background Comparison:

When statistical background comparison (central tendency) indicates concentrations in site surface water are not greater than background (site < bkgd), that preliminary COC was eliminated as a final COC. Statistical background comparisons are presented in Section 6 tables of the RI report. When the background comparison indicates site > bkgd, then further review of that preliminary COC was performed based on nature of mine-related contamination.

2. Nature of Mine-Related Contamination:

For those preliminary COCs that were not eliminated based on background comparisons, further review of that preliminary COC was performed based on nature of mine-related contamination. Literature review was performed to evaluate likeliness of preliminary COC being associated with TSMD ore bodies (Table 7-1 of RI report). If preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was eliminated as a final COC.

	Based on the literature review, it was concluded that aluminum, chromium, and vanadium are not likely associated with TSMD ore bodies; therefore they were excluded as final COCs.
COC	Identified as preliminary COC based on the inhalation of water vapor during sweat lodge use only.
	Final COC.

Bkgd = background
COC = chemical of concern
ELCR = excess lifetime cancer risk
HHRA = human health risk assessment
OU5 = Operable Unit 5
RI = remedial investigation
TSMD = Tri-State Mining District
UTL = upper tolerance limit

Table 6-10. Final Surface Water COCs for Tar Creek OU5 (Aquatic Worker - Surface Water)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Elm Creek		Tar Creek		Neosho River		Beaver Creek [c]		Lost Creek [c]		Lower Spring River [c]	
Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]
		Arsenic	Yes	Arsenic	No						
Cadmium	Yes					None		None		None	
		Chromium	Yes	Chromium	No						
		Cobalt	Yes								
		Manganese	Yes								
		Nickel	Yes								

Notes:

[a] Preliminary surface water COCs were identified for direct exposure (ingestion and dermal contact) through work activities (Table 6-3).

[b] Lead in surface water was not evaluated for aquatic workers because of the limitations of the ALM. The evaluation of lead exposure was performed in Appendix E.

[c] No preliminary COCs were identified for Beaver Creek, Lost Creek, and Lower Spring River.

[d] Results of background comparisons are presented as follows:

Yes	site > bkgd; statistically significant increase in site concentrations above background
No	no statistical difference between site and background

Refinement of the preliminary COCs:

To identify the final COCs, the lists of preliminary COCs were refined using a two-step process (see decision flow chart on Figure 6-1):

1. Background comparison, and 2. Nature of mine-related contamination.

1. Background Comparison:

When statistical background comparison (central tendency) indicates concentrations in site surface water are not greater than background (site < bkgd), that preliminary COC was eliminated as a final COC. Statistical background comparisons are presented in Section 6 tables of the RI report. When the background comparison indicates site > bkgd, then further review of that preliminary COC was performed based on nature of mine-related contamination.

2. Nature of Mine-Related Contamination:

For those preliminary COCs that were not eliminated based on background comparisons, further review of that preliminary COC was performed based on nature of mine-related contamination. Literature review was performed to evaluate likeliness of preliminary COC being associated with TSMD ore bodies (Table 7-1 of RI report). If preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was eliminated as a final COC.

Based on the literature review, it was concluded that chromium is not likely to be associated with TSMD ore bodies; therefore, it was excluded as a final COC.

Final COC.

ALM = Adult Lead Methodology
Bkgd = background
COC = chemical of concern
ELCR = excess lifetime cancer risk
HHRA = human health risk assessment
OU5 = Operable Unit 5
RI = remedial investigation
TSMD = Tri-State Mining District

Table 6-11. Final Surface Water COCs for Tar Creek OU5 (General Public - Surface Water)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Elm Creek		Tar Creek		Neosho River		Beaver Creek		Lost Creek [c]		Lower Spring River [c]	
Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]	Preliminary COC [a,b]	Exceeds Bkgd? [d]
		Arsenic	Yes	Arsenic	No	Arsenic	No				
Cadmium	Yes	Cadmium	Yes					None		None	
		Chromium	Yes	Chromium	No	Chromium	No				
		Cobalt	Yes								
		Iron	Yes								
Lead	Yes	Lead	Yes			Lead	Yes			Lead	No
Manganese	No	Manganese	Yes								

Notes:

[a] Preliminary surface water COCs were identified for two direct exposure (ingestion and dermal contact) scenarios combined (recreational activities and potable use) based on hazard estimates for child receptor and ELCR estimates for adult/child aggregate receptor (Tables 6-4 and 6-5).

[b] The evaluation of lead exposure was performed in Appendix E.

[c] No preliminary COCs were identified for Lost Creek.

[d] Results of background comparisons are presented as follows:

Yes	site > bkgd; statistically significant increase in site concentrations above background
No	no statistical difference between site and background

Refinement of the preliminary COCs:

To identify the final COCs, the lists of preliminary COCs were refined using a two-step process (see decision flow chart on Figure 6-1):

1. Background comparison, and 2. Nature of mine-related contamination.

1. Background Comparison:

When statistical background comparison (central tendency) indicates concentrations in site surface water are not greater than background (site < bkgd), that preliminary COC was eliminated as a final COC. Statistical background comparisons are presented in Section 6 tables of the RI report. When the background comparison indicates site > bkgd, then further review of that preliminary COC was performed based on nature of mine-related contamination.

2. Nature of Mine-Related Contamination:

For those preliminary COCs that were not eliminated based on background comparisons, further review of that preliminary COC was performed based on nature of mine-related contamination. Literature review was performed to evaluate likeliness of preliminary COC being associated with TSMD ore bodies (Table 7-1 of the RI report). If preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was eliminated as a final COC.

Based on the literature review, it was concluded that chromium is not likely to be associated with TSMD ore bodies; therefore, it was excluded as a final COC.

Final COC.

Bkgd = background
COC = chemical of concern
ELCR = excess lifetime cancer risk
HHRA = human health risk assessment
OU5 = Operable Unit 5
RI = remedial investigation
TSMD = Tri-State Mining District

Table 6-12. Final Biota COCs for Tar Creek OU5 (Tribal Lifeway - Biota)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Preliminary COC [a,b,c]	Sediment Background Comparison Results [d]						Comment
	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River	
Aluminum	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	
Antimony	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	Yes (us)**	Comment [e]
Arsenic	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	
Barium	No (us)	No (s/us)	Yes (us)	No (s/us)	No (us)	Yes (s)**	Site > Bkgd
Beryllium	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	
Cadmium	Yes (s/us)	Yes (s/us)	Yes (s/us)	Yes (s/us)	Yes (s/us)	Yes (s/us)	Site > Bkgd
Cobalt	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	
Copper	Yes (us)	Yes (s/us)	No (us)	No (s/us)	No (us)	Yes (s/us)	Site > Bkgd
Iron	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	
Lead	Yes (s/us)	Yes (s/us)	No (s/us)	Yes (s/us)	No (s/us)	Yes (s/us)	Site > Bkgd
Manganese	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	
Mercury	Yes (us)	Yes (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	Comment [f]
Nickel	No (us)	Yes (s)**	No (us)	No (s/us)	No (us)	Yes (s)**	Site > Bkgd
Selenium	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	
Silver	---	Yes (s)**	No (us)	Yes (s)**	---	Yes (s)**	Site > Bkgd
Vanadium	No (us)	No (us)	No (us)	No (us)	No (us)	No (us)	
Zinc	Yes (s/us)	Yes (s/us)	Yes (s)**	Yes (us)	Yes (s)**	Yes (s/us)	Site > Bkgd

Notes:

[a] Preliminary biota COCs were identified for food consumption (ingestion of fish, shellfish, aquatic plants, amphibian/aquatic reptile, and aquatic mammals) and medicinal use (salve) of aquatic plant scenarios combined based on hazard estimates for child receptor and ELCR estimates for adult/child aggregate receptor (Tables 6-1 and 6-2).

[b] Preliminary COCs were identified based on sitewide dataset.

[c] The evaluation of lead exposure was performed in Appendix E.

[d] Results of background comparisons are presented as follows:

Yes (s/us)	site > bkgd based on both sieved and unsieved data
Yes (us)	site > bkgd based on unsieved data (sieved data are not available)
Yes (us)**	site > bkgd based on unsieved data (inconsistent results: sieved data indicate no difference)
Yes (s)**	site > bkgd based on sieved data (inconsistent results: unsieved data indicate no difference)
No (s/us)	no statistical difference between site and bkgd based on both sieved and unsieved data
No (us)	no statistical difference between site and bkgd based on unsieved data (sieved data are not available)
---	no background comparison was performed

[e] Statistical background comparison indicates site concentrations are greater than background only for unsieved data at Lower Spring River. Because of the high frequency of non-detected results (87%) in the Lower Spring River dataset, antimony was excluded as a final COC based on the background comparison.

[f] Excluded as a final COC because it is unlikely to be associated with TSMD ore bodies.

Refinement of the preliminary COCs:

To identify the final COCs, the list of preliminary COCs was refined using a two-step process (see decision flow chart on Figure 6-1):

1. Background comparison, and 2. Nature of mine-related contamination.

1. Background Comparison:

The background comparisons between site and background datasets were performed based on sediment data. See the rationale for use of sediment data for the identification of final COCs in Section 6.4.2.

When statistical background comparison (central tendency) indicates concentrations in site sediment are not greater than background (site < bkgd), that preliminary COC was eliminated as a final COC. Statistical background comparisons are presented in Section 6 tables of the RI report. When the background comparison indicates site > bkgd, then further review of that preliminary COC was performed based on nature of mine-related contamination.

When the background comparisons were performed on both sieved and unsieved datasets, if at least one of the datasets indicates site > bkgd, the preliminary COC was conservatively retained for further evaluation.

Because the background comparison was performed based on watershed-specific datasets, results of comparison are presented by watershed. If site > bkgd was indicated in any of the watershed-specific datasets, the preliminary COC was conservatively retained for the further evaluation (except for antimony). An exception was made for antimony (see the comment below).

Table 6-12. Final Biota COCs for Tar Creek OU5 (Tribal Lifeway - Biota)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

2. Nature of Mine-Related Contamination:

For those preliminary COCs that were not eliminated based on background comparisons, further review of that preliminary COC was performed based on nature of mine-related contamination. Literature review was performed to evaluate likeliness of preliminary COC being associated with TSMD ore bodies (Table 7-1 of RI report). If preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was eliminated as a final COC.

	Based on the literature review, it was concluded that mercury is not likely to be associated with TSMD ore bodies; therefore, it was excluded as a final COC.
	Final COC.

Bkgd = background

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

OU5 = Operable Unit 5

RI = remedial investigation

TSMD = Tri-State Mining District

Table 6-13. Final Fish COCs for Tar Creek OU5 (General Public - Fish)

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Preliminary COC [a,b,c]	Sediment Background Comparison Results [d]						Comment
	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River	
Antimony	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	Yes (us)**	Comment [e]
Lead	Yes (s/us)	Yes (s/us)	No (s/us)	Yes (s/us)	No (s/us)	Yes (s/us)	
Mercury	Yes (us)	Yes (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	Comment [f]
Selenium	No (us)	No (s/us)	No (us)	No (s/us)	No (us)	No (s/us)	

Notes:

[a] Preliminary fish COCs were identified for fish consumption pathway based on hazard estimates for child receptor and ELCR estimates for adult/child aggregate receptor (Tables 6-4 and 6-5).

[b] Preliminary COCs were identified based on sitewide dataset.

[c] The evaluation of lead exposure was performed in Appendix E.

[d] Results of background comparisons are presented as follows:

Yes (s/us)	site > bkgd based on both sieved and unsieved data
Yes (us)	site > bkgd based on unsieved data (sieved data are not available)
Yes (us)**	site > bkgd based on unsieved data (inconsistent results: sieved data indicate no difference)
No (s/us)	no statistical difference between site and bkgd based on both sieved and unsieved data
No (us)	no statistical difference between site and bkgd based on unsieved data (sieved data are not available)

[e] Statistical background comparison indicates site concentrations are greater than background only for unsieved data at Lower Spring River. Because of the high frequency of non-detected results (87%) in the Lower Spring River dataset, antimony was excluded as a final COC based on the background comparison.

[f] Excluded as a final COC because it is unlikely to be associated with TSMD ore bodies

Refinement of the preliminary COCs:

To identify the final COCs, the list of preliminary COCs was refined using a two-step process (see decision flow chart on Figure 6-1): 1. Background comparison, and 2. Nature of mine-related contamination.

1. Background Comparison:

The background comparisons between site and background datasets were performed based on sediment data. See the rationale for use of sediment data for the identification of final COCs in Section 6.4.2.

When statistical background comparison (central tendency) indicates concentrations in site sediment are not greater than background (site < bkgd), that preliminary COC was eliminated as a final COC. Statistical background comparisons are presented in Section 6 tables of the RI report. When the background comparison indicates site > bkgd, then further review of that preliminary COC was performed based on nature of mine-related contamination.

When the background comparisons were performed on both sieved and unsieved datasets, if at least one of the datasets indicates site > bkgd, the preliminary COC was conservatively retained for further evaluation.

Because the background comparison was performed based on watershed-specific datasets, results of comparison are presented by watershed. If site > bkgd was indicated in any of the watershed-specific datasets, the preliminary COC was conservatively retained for further evaluation (except for antimony). An exception was made for antimony (see the comment below).

2. Nature of Mine-Related Contamination:

For those preliminary COCs that were not eliminated based on background comparisons, further review of that preliminary COC was performed based on nature of mine-related contamination. Literature review was performed to evaluate likeliness of preliminary COC being associated with TSMD ore bodies (Table 7-1 of the RI report). If preliminary COC is not likely to be associated with TSMD ore bodies, that preliminary COC was eliminated as a final COC.

	Because of the high frequency of non-detected results (87%) in the Lower Spring River dataset, antimony was excluded as a final COC based on the background comparison.
	Based on the literature review, it was concluded that mercury is not likely to be associated with TSMD ore bodies; therefore, it was excluded as a final COC.
	No Final COC was identified.

Bkgd = background

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

OU5 = Operable Unit 5

RI = remedial investigation

TSMD = Tri-State Mining District

Table 6-14. Final COCs for Tar Creek OU5

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Final COCs	Sitewide (Biota Only)	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
Sediment							
Cadmium		TL	TL, AW		TL		
Lead		TL, AW, GP	TL, AW, GP		TL, GP		TL, GP
Zinc		TL	TL		TL		
Surface Water							
Antimony		TL					
Arsenic			TL, AW, GP				
Barium				TL			
Cadmium		TL, AW, GP	TL, GP		TL		
Cobalt			TL, AW, GP		TL		
Iron			TL, GP	TL			
Lead[a]		TL, GP	TL, GP		TL, GP		
Manganese			TL, AW, GP				
Nickel		TL	TL, AW		TL		
Zinc		TL	TL				
Biota[b]							
Barium	TL						
Cadmium	TL						
Copper	TL						
Lead	TL, GP						
Nickel	TL						
Silver	TL						
Zinc	TL						

Notes:

[a] Lead in surface water was not evaluated for aquatic workers because of the limitations of the ALM.

[b] Final COCs were identified based on sitewide dataset.

Final COCs are identified for the following receptors: TL = Tribal Lifeway, AW = Aquatic Worker, GP = General Public.

ALM = Adult Lead Methodology

COC = chemical of concern

HHRA = human health risk assessment

OU5 = Operable Unit 5

Table 6-15. Summary of Receptor Hazards for Final COCs - Tribal Lifeway Child [a]

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 10.2.RME)	% [d] contribution	Tar Creek (TABLE 10.8.RME)	% [d] contribution	Neosho River (TABLE 10.15.RME)	% [d] contribution	Beaver Creek (TABLE 10.18.RME)	% [d] contribution
Non-Carcinogenic Hazard Index [b]										
Sediment (Rivers & Creeks)	Hunting, Fishing, Gathering and Recreational Activities	Ingestion	11	7.1%	10	2.0%			5	4.5%
		Dermal	0.2	0.1%	0.5	0.1%			0.2	0.2%
	Total (Sediment) [d]		11	7%	10	2%			5	5%
	Target Organ-Specific Total HI	Hematologic	8		2		None		2	
		Immune	8		2				2	
		Urinary	3		9				4	
	Final Sediment COCs [b]		Cadmium	25%	Cadmium	84%	None		Cadmium	67%
			Zinc	75%	Zinc	16%			Zinc	33%
Surface Water (Rivers & Creeks)	Hunting, Fishing, Gathering and Recreational Activities	Ingestion	3	2.1%	13	2.7%	0.3	0.3%	0.9	0.8%
		Dermal	3	1.7%	4	0.9%	0.03	0.03%	0.1	0.1%
		Total	6	3.8%	18	3.6%	0.4	0.4%	1	0.9%
	Potable Use	Ingestion	6	3.6%	22	4.6%	0.6	0.6%	2	1.4%
		Dermal	0.4	0.2%	0.6	0.1%	0.005	0.005%	0.02	0.02%
		Total	6	3.8%	23	4.7%	0.6	0.6%	2	1.4%
	Sweat Lodge	Ingestion	7	4.6%	29	5.9%	0.7	0.7%	2.0	1.7%
		Dermal	0.7	0.4%	1	0.2%	0.009	0.009%	0.04	0.031%
		Inhalation	28	18.3%	313	64.0%	2	2.2%	11	9.8%
		Total	36	23.3%	342	70.1%	3	2.9%	13	11.5%
	Total (Surface Water) [d]		48	31%	383	78%	4	4%	16	14%
	Target Organ-Specific Total HI	Cardiovascular	NA		33		NA		NA	
		Dermal	NA		33		NA		NA	
		Developmental	NA		16		2		NA	
		Endocrine	NA		16		NA		2	
		Gastrointestinal	NA		11		2		NA	
		Hematologic	4		3		NA		NA	
		Immune	3		3		NA		NA	
		Nervous	NA		253		NA		NA	
		Reproductive	NA		16		NA		NA	
		Respiratory	≤ 1		78		NA		3	
		Urinary	42		18		NA		NA	
		Whole Body	≤ 1		3		NA		NA	
	Final Surface Water COCs [b]		Antimony	1.9%	Arsenic	9%	Barium	60%	Cadmium	12%
			Cadmium	88%	Cadmium	4.6%	Iron	40%	Cobalt	80%
			Nickel	3.2%	Cobalt	14%			Nickel	7.6%
			Zinc	7%	Iron	2.9%				
					Manganese	62%				
					Nickel	7.4%				
					Zinc	0.8%				

Table 6-15. Summary of Receptor Hazards for Final COCs - Tribal Lifeway Child [a]

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 10.2.RME)	% [d] contribution	Tar Creek (TABLE 10.8.RME)	% [d] contribution	Neosho River (TABLE 10.15.RME)	% [d] contribution	Beaver Creek (TABLE 10.18.RME)	% [d] contribution
Aquatic Biota Animal/Plant	Fish	Ingestion	0.7	0.5%	0.7	0.2%	0.7	0.8%	0.7	0.6%
	Shellfish	Ingestion	3	1.9%	3	0.6%	2.9	3.0%	2.9	2.5%
	Amphibian/Aquatic Reptile	Ingestion	0.2	0.1%	0.2	0.0%	0.2	0.2%	0.2	0.2%
	Semi-Aquatic Mammals	Ingestion	0.6	0.4%	0.6	0.1%	0.6	0.6%	0.6	0.5%
	Aquatic Plant (food)	Ingestion	91	58.9%	91	18.6%	91	91.7%	91	77.7%
	Aquatic Plant (salve)	Dermal	0.01	0.006%	0.01	0.0019%	0.01	0.010%	0.01	0.008%
	Total (Biota) [d]		95	62%	95	20%	95	96%	95	82%
	Target Organ-Specific Total HI	Dermal	≤ 1		See Note [c]					
		Gastrointestinal	2							
		Hematologic	24							
		Immune	24							
		Urinary	68							
		Whole Body	≤ 1							
	Final Biota COCs [b,c]		Barium	1.1%						
			Cadmium	71%						
			Copper	2.5%						
			Nickel	0.5%						
			Silver	0.5%						
			Zinc	25%						
Total (Receptor) [d]			154	100%	488	100%	99	100%	117	100%

Notes:

[a] Because the child exposure scenario yields a higher non-carcinogenic HI than the adult exposure scenario, a summary of non-carcinogenic HI for the final COCs is presented for child exposure scenario.

[b] The lists of final COCs in this table do not include lead. The evaluation of lead exposure was performed in Appendix E. The evaluation of mine discharge was performed in Appendix F.

[c] The non-carcinogenic HI associated with aquatic biota (animal/plant) was calculated based on the sitewide dataset. The sitewide non-carcinogenic HI presented under Elm Creek is applicable to all six watersheds for estimating total non-carcinogenic HI for the receptor.

[d] Percent (%) contribution for each exposure route and total (exposure medium) is calculated as percentage of total (receptor) HI. Percent contribution for final COC is calculated on an exposure medium basis as percentage of total (exposure medium).

COC = chemical of concern

HHRA = human health risk assessment

HI = hazard index

NA = not applicable; target organ is not associated with the final COCs

RME = reasonable maximum exposure

Table 6-16. Summary of Receptor Risks for Final COCs - Tribal Lifeway Adult/Child Aggregate

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 10.3.RME)	% [b] contribution	Tar Creek (TABLE 10.9.RME)	% [b] contribution	Beaver Creek (TABLE 10.19.RME)	% [b] contribution
Excess Lifetime Carcinogenic Risk [a]								
Surface Water (Rivers & Creeks)	Hunting, Fishing, Gathering and Recreational Activities	Ingestion	NV		4E-04	6.4%	NV	
		Dermal	NV		7E-05	1.1%	NV	
		Total	NV		5E-04	7.5%	NV	
	Potable Use	Ingestion	NV		2E-03	27.1%	NV	
		Dermal	NV		1E-05	0.1%	NV	
		Total	NV		2E-03	27.3%	NV	
	Sweat Lodge	Ingestion	NV		9E-04	12.3%	NV	
		Dermal	NV		1E-05	0.2%	NV	
		Inhalation	5E-04	100%	4E-03	52.7%	5E-04	100%
		Total	5E-04	100%	5E-03	65.2%	5E-04	100%
	Total (Surface Water)		5.E-04	100%	7.E-03	100%	5.E-04	100%
	Final Surface Water COCs [a]		Cadmium	93%	Arsenic	61%	Cadmium	4%
			Nickel	7%	Cadmium	3%	Cobalt	91%
					Cobalt	27%	Nickel	5%
					Nickel	8%		
Total (Receptor)			**5.E-04**	**100%**	**7.E-03**	**100%**	**5.E-04**	**100%**

Notes:

[a] The list of final COCs in this table does not include lead. The evaluation of lead exposure was performed in Appendix E. The evaluation of mine discharge was performed in Appendix F.

[b] Percent (%) contribution is calculated as percentage of total (receptor) ELCR.

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

NA = not applicable

NV = no ELCR value is estimated because no carcinogenic COCs are identified for ingestion and dermal contact exposure routes

RME = reasonable maximum exposure

Table 6-17. Summary of Receptor Hazards and Risks for Final COCs - Aquatic Worker

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 10.4.RME)	% [b] contribution	Tar Creek (TABLE 10.10.RME)	% [b] contribution
Non-Carcinogenic Hazard Index [a]						
Sediment (Rivers & Creeks)	Work Activities	Ingestion			1	25.3%
		Dermal			0.3	5.0%
	Total (Sediment) [b]				2	30%
	Target Organ-Specific Total HI	Urinary			2	
	Final Sediment COCs [a]		None		Cadmium	100%
Surface Water (Rivers & Creeks)	Work Activities	Ingestion	0.4	19.0%	2	29.6%
		Dermal	2	81.0%	2	40.2%
	Total (Surface Water) [b]		2	100%	4	70%
	Target Organ-Specific Total HI	Nervous	NA		3	
		Respiratory	NA		2	
		Urinary	2		NA	
	Final Surface Water COCs [a]		Cadmium	100%	Arsenic	19%
					Cobalt	16%
					Manganese	60%
					Nickel	5%
Total (Receptor) [b]			**2**	**100%**	**6**	**100.0%**
Excess Lifetime Carcinogenic Risk [a]						
Surface Water (Rivers & Creeks)	Work Activities	Ingestion			1.E-04	82.4%
		Dermal			2.E-05	17.6%
	Total (Surface Water) [b]				1.E-04	100%
	Final Surface Water COCs [a]				Arsenic	100%
Total (Receptor) [b]					**1.E-04**	**100%**

Notes:

[a] The list of final COCs in this table does not include lead. The evaluation of lead exposure was performed in Appendix E.

[b] Percent (%) contribution for each exposure route and total (exposure medium) is calculated as percentage of total (receptor) HI or ELCR. Percent contribution for final COC is calculated on an exposure medium basis as percentage of total (exposure medium).

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

HI = hazard index

NA = not applicable; target organ is not associated with the final COCs

RME = reasonable maximum exposure

Table 6-18. Summary of Receptor Hazards for Final COCs - General Public Child

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek (TABLE 10.6.RME)	% [b] contribution	Tar Creek (TABLE 10.12.RME)	% [b] contribution
Non-Carcinogenic Hazard Index [a]						
Surface Water (Rivers & Creeks)	Recreational Activities	Ingestion	0.05	1.1%	0.2	1.2%
		Dermal	0.05	1.2%	0.08	0.4%
		Total	0.1	2.3%	0.3	1.6%
	Potable Use	Ingestion	4	89.8%	20	95.7%
		Dermal	0.3	7.9%	0.6	2.8%
		Total	4	98%	20	98%
	Total (Surface Water)		4	100%	20	100%
	Target Organ-Specific Total HI	Cardiovascular	NA		6	
		Dermal	NA		6	
		Endocrine	NA		5	
		Gastrointestinal	NA		4	
		Nervous	NA		4	
		Urinary	4		2	
	Final Surface Water COCs [a]		Cadmium	100%	Arsenic	28%
					Cadmium	9%
					Cobalt	26%
					Iron	18%
					Manganese	19%
Total (Receptor)			**4**	**100%**	**20**	**100%**

Notes:

[a] Because the child exposure scenario yields higher non-carcinogenic HIs than the adult exposure scenario, a summary of HIs for the final COCs is presented for child exposure scenario.

The list of final COCs in this table does not include lead. The evaluation of lead exposure was performed in Appendix E.

The evaluation of mine discharge was performed in Appendix F.

[b] Percent (%) contribution is calculated as percentage of total (receptor) ELCR.

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

HI = hazard index

NA = not applicable; target organ is not associated with the final COCs

RME = reasonable maximum exposure

Table 6-19. Summary of Receptor Risks for Final COCs - General Public Adult/Child Aggregate

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Tar Creek (TABLE 10.13.RME)	% [b] contribution
Excess Lifetime Carcinogenic Risk [a]				
Surface Water (Rivers & Creeks)	Recreational Activities	Ingestion	4.E-06	0.6%
		Dermal	4.E-07	0.1%
		Total	4.E-06	0.7%
	Potable Use	Ingestion	7.E-04	98.8%
		Dermal	3.E-06	0.5%
		Total	7.E-04	99.3%
	Total (Surface Water)		7.E-04	100%
	Final Surface Water COCs [a]		Arsenic	100%
Total (Receptor) [b]			**7.E-04**	**100%**

Notes:

[a] The list of final COCs in this table does not include lead. The evaluation of lead exposure was performed in Appendix E. The evaluation of mine discharge was performed in Appendix F.

[b] Percent (%) contribution is calculated as percentage of total (receptor) ELCR.

COC = chemical of concern

ELCR = excess lifetime cancer risk

HHRA = human health risk assessment

RME = reasonable maximum exposure

Table 6-20. General Uncertainties in the Human Health Risk Assessment

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

HHRA Report Section	Assessment	Topic	Methodology	Probable Effect on Site-Related Risk Estimates
Section 3	Data Evaluation	Selection of COPCs	When a chemical was 100% non-detected in an exposure medium, it was assumed to be not present in the medium.	No significant impact
			Chemicals with maximum detected concentrations above screening levels were retained as COPCs even if they may be within background levels.	Overestimates site-related risks
Section 4	Exposure Assessment	Use of the EPC in estimation of COPC intake	Receptors are assumed to be exposed to the EPCs (conservative estimation of average concentrations based on UCL of the mean or maximum detected concentration) for the entire exposure duration.	Likely overestimates risks
		Use of the conservative, high-end exposure assumptions in estimation of COPC intake	Numerical exposure factors (e.g., ingestion rate, exposure frequency, exposure duration) used in the estimation of COPC intake are selected conservatively.	Likely overestimates risks
Section 5	Toxicity Assessment	Toxicity values derived from animal studies	Extrapolation from animal to human toxicity may introduce error because of differences in pharmacokinetics, target organs, and population variability.	Under- or overestimates risks
		Toxicity values derived primarily from high doses (whereas most environmental exposures occur at low doses)	This assumes linearity at low doses.	Likely overestimates risks
		Lack of dermal toxicity values	Dermal toxicity values are not available; therefore, adjusted oral value toxicity values were used.	May under- or overestimate risk
		Speciated chromium data are not available	Cr (VI) toxicity values were used for exposure through aqueous media such as surface water and mine discharge, whereas Cr (III) toxicity values were used for exposure through solid media such as sediment and food.	Under- or overestimates risks
		Missing toxicity values	Oral RfD (phosphorus, silica, and thallium) and inhalation RfC (antimony, copper, iron, lithium, mercury, molybdenum, phosphorus, silica, silver, thallium, and zinc) are not available.	Underestimates risk

Table 6-20. General Uncertainties in the Human Health Risk Assessment

Tar Creek Superfund Site Operable Unit 5 HHRA

Ottawa County, Oklahoma

HHRA Report Section	Assessment	Topic	Methodology	Probable Effect on Site-Related Risk Estimates
Section 6	Risk Characterization	Risk from multiple chemicals	Assumes additivity of risks from multiple chemicals; chemical mixtures may actually have synergistic, potentiating, or antagonistic effects.	May under- or overestimate risks
		Combination of several upper-bound assumptions	The result of combining several upper-bound assumptions is that the final estimate of potential exposure or potential risk is conservative.	May overestimate risks

Notes:

COPC = chemical of potential concern

EPC = exposure point concentration

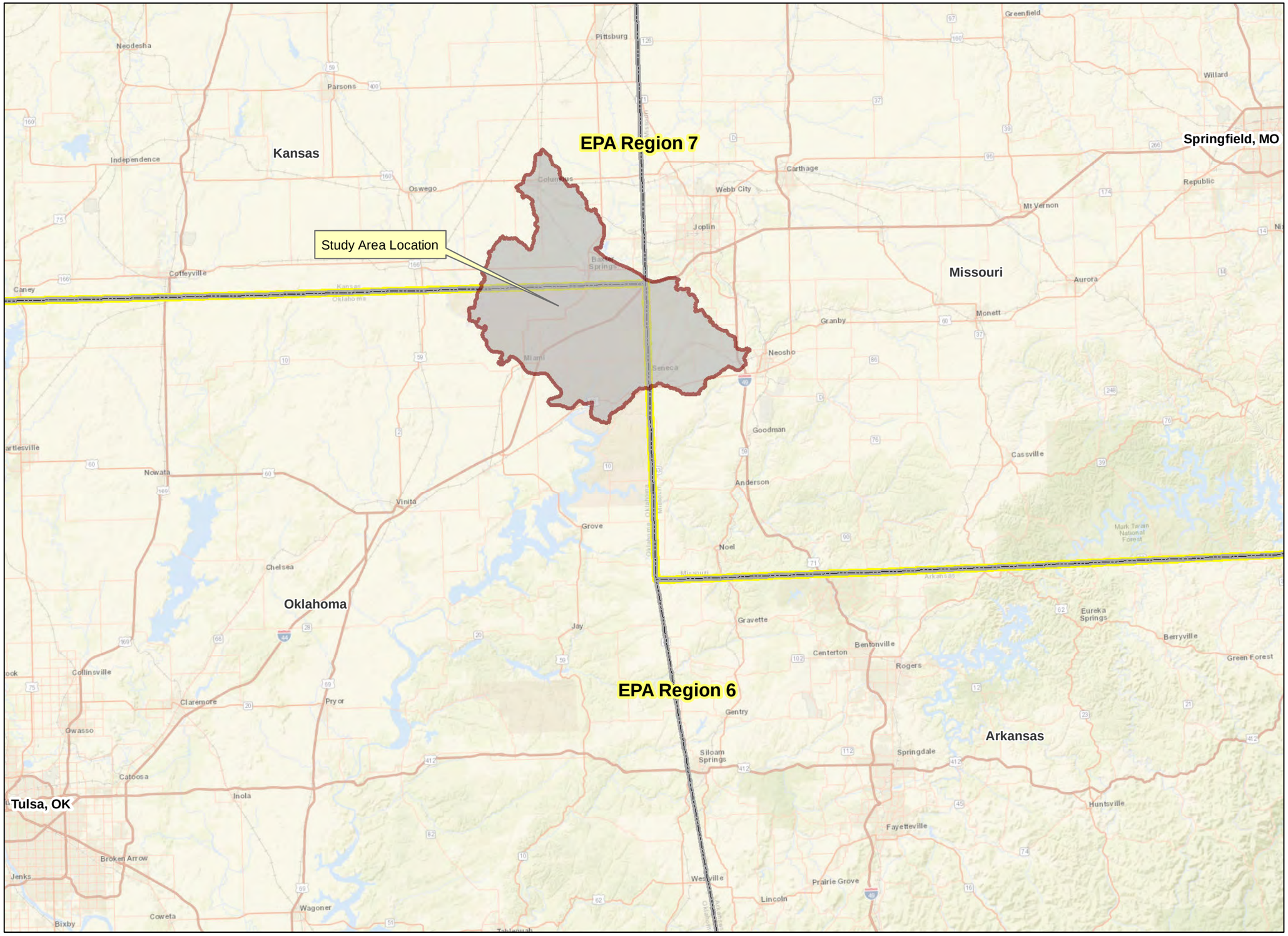
HHRA = human health risk assessment

RfC = reference concentration

RfD = reference dose

UCL = upper confidence limit

Figures



Legend

- Study Area Location
- State Boundary
- EPA Region Boundary

Notes:
1. Imagery Source: ESRI World Street Map online mapping service
2. Operable Unit 5 does not have specific boundaries, but is defined by the extent of the watersheds that have been identified by EPA as relevant to the superfund site.

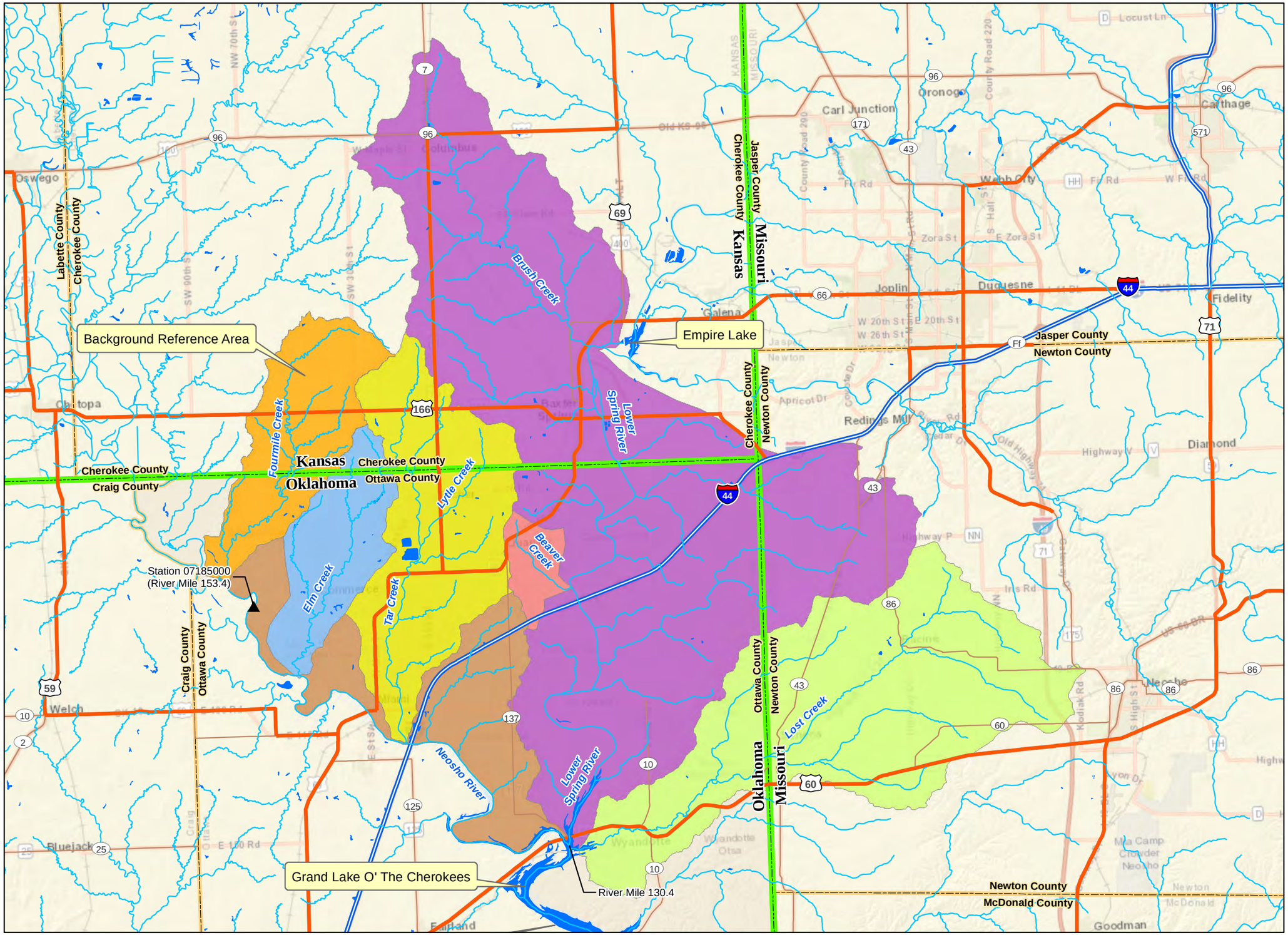
EPA = Environmental Protection Agency

N

0 11 22 Miles

Figure 1-1.
Study Area Location Map
Tar Creek Superfund Site
Operable Unit 5 HHRA
Ottawa County, Oklahoma

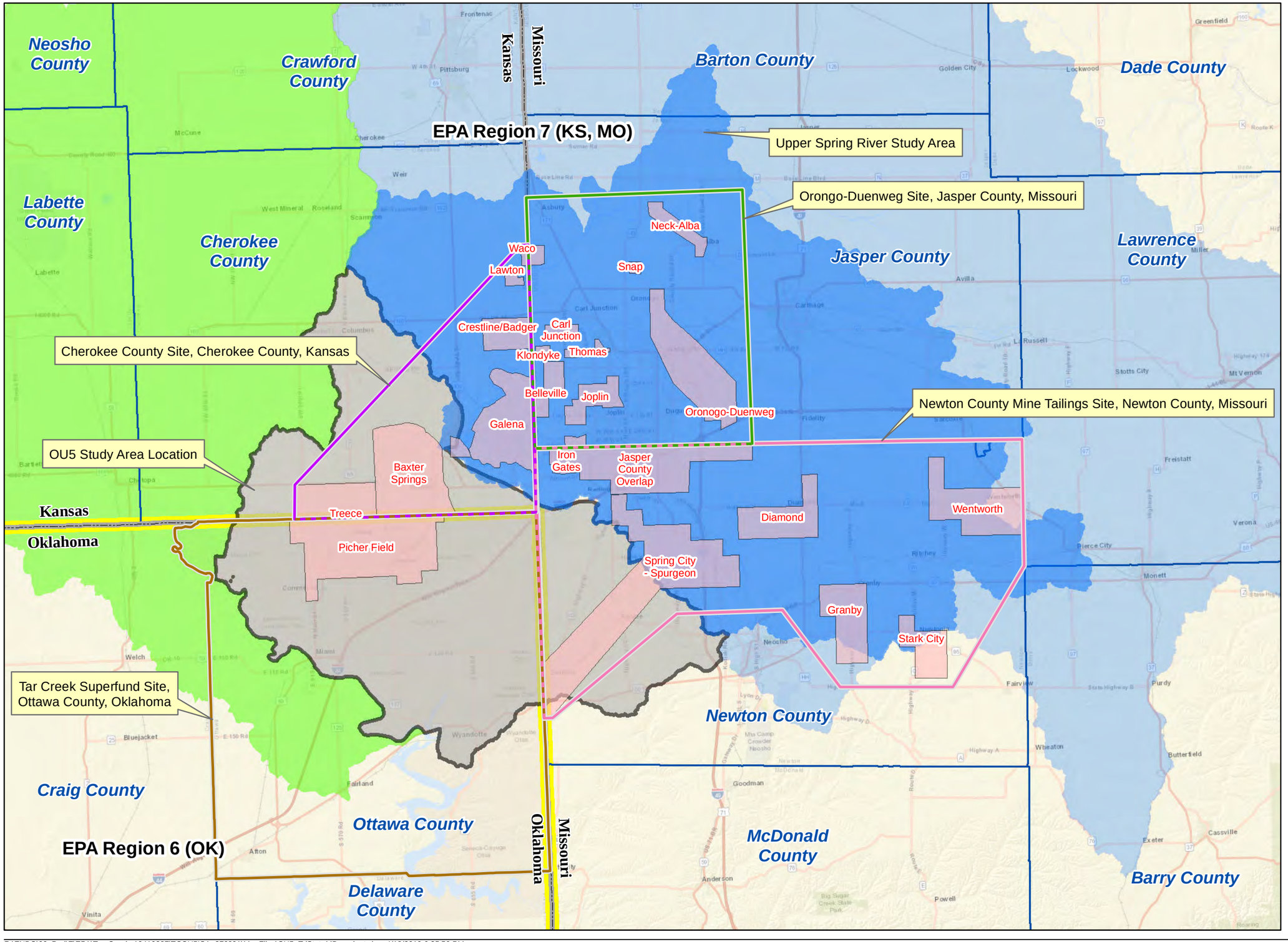
R:\ENBG\00_Proj\E\EPA\Tar_Creek_10419387\TCOU5ISA_379891\MapFiles\OU5_LocationMap.mxd gtwigg 4/3/2019 1:01:33 PM



Notes:
1) Imagery Source: ESRI World Street Map online mapping service
2) Operable Unit 5 (OU5) does not have specific boundaries, but is defined by the extent of the watersheds that have been identified by the EPA as relevant to Tar Creek Superfund Site OU5.
3) River Mile 130.4 represents the downstream extent of the OU5 study area.

NHD = National Hydrography Dataset
USGS = U.S. Geological Survey

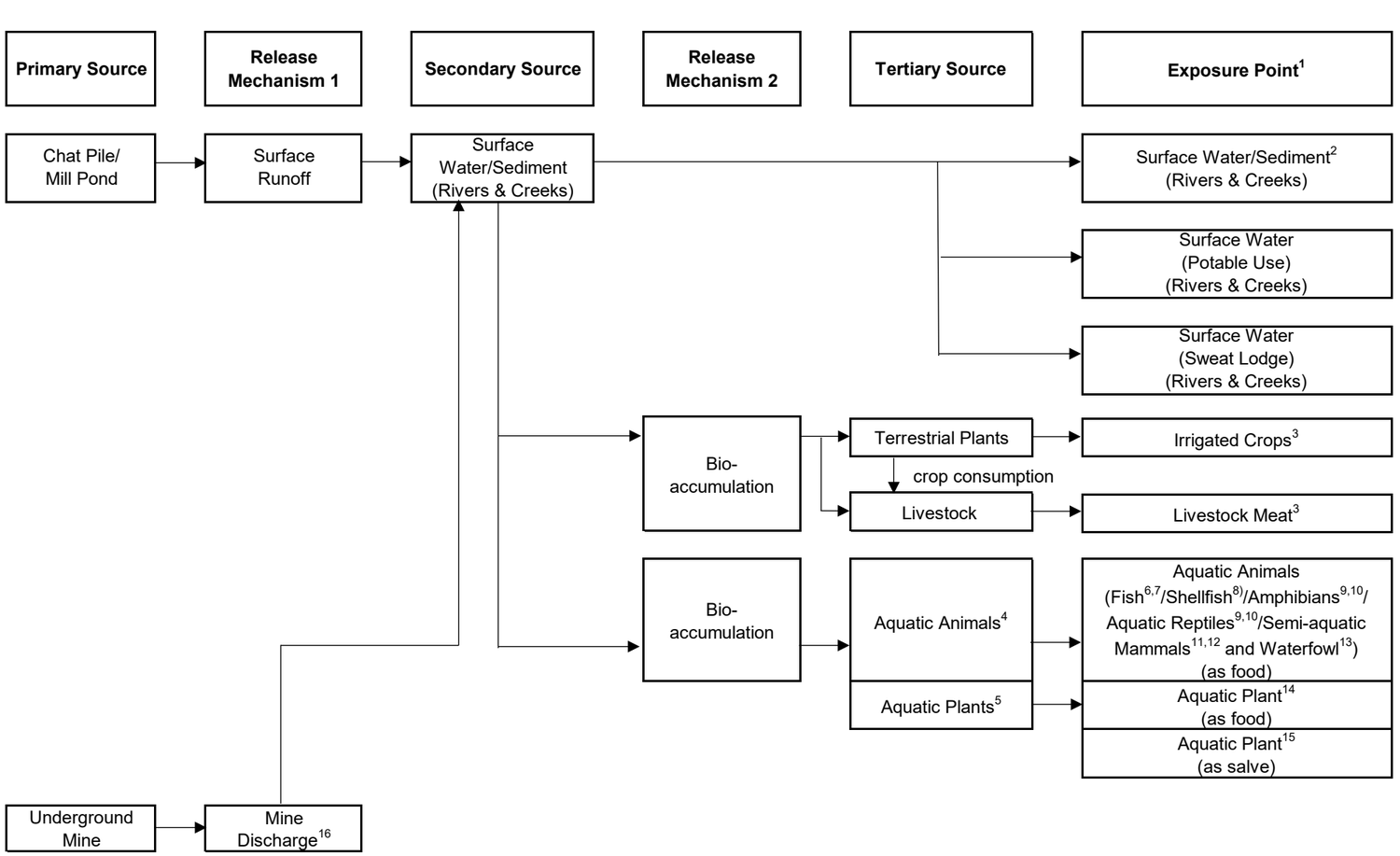
Figure 2-1.
Operable Unit 5 Watersheds
Tar Creek Superfund Site
Operable Unit 5 HHRA
Ottawa County, Oklahoma



Notes:
1. Imagery Source: ESRI World Street Map online mapping service
2. Operable Unit 5 does not have specific boundaries, but is defined by the extent of the watersheds that have been identified by EPA as relevant to the superfund site.
3. Tri-State Mining District Boundary adapted from report: *Tri-State Mining District legacy in northeastern Oklahoma (J.S. Abers)*

EPA = Environmental Protection Agency
OU5 = Operable Unit 5
OU4 = Operable Unit 4

Figure 2-2.
Tri-State Mining District Map
Tar Creek Superfund Site
Operable Unit 5 HHRA
Ottawa County, Oklahoma



Exposure Route	Potential Receptor: Tribal Lifeway (adult/child)	Potential Receptor: Aquatic Worker (adult)	Potential Receptor: General Public (adult/child)
Ingestion, Dermal	√	√	√
Ingestion, Dermal	√		√
Ingestion, Dermal, Inhalation	√		
Ingestion	√		√ (Fish[7] and Waterfowl[13] only)
Ingestion	√		
Dermal	√		

√ indicates potentially complete pathway

Notes:

[1] Evaluation of site media is performed separately for each watershed.

[2] Sediment (0 to 12 inches deep) from saturated zones of perennial rivers or creeks.

[3] The use of surface water for the irrigation of crops or as drinking water for livestock is unknown and expected to be unlikely due to the extent of annual rainfall in the area.

[4] Terrestrial small game (birds, rabbits) and large game (deer, elk) were addressed under Operable Unit 4 (Source Material, Transition Zone Soil, Rural Residential Yards, and Wells).

[5] Aquatic plants growing in the wet bank-to-bank section of perennial flowing rivers and creeks.

[6] Potential risk associated with fish consumption by the Tribal lifeway receptors is evaluated using two datasets: (1) whole body eviscerated, and (2) head with bones.

[7] Potential risk associated with fish consumption by the general public is evaluated using the fish filet dataset.

[8] Potential risk associated with shellfish consumption is evaluated using the Asian clam and limited mussel samples.

[9] Amphibians and aquatic reptiles living in the wet bank-to-bank section of perennial flowing rivers and creeks.

[10] Potential risk associated with amphibian/aquatic reptile consumption is evaluated using the frog leg samples.

[11] Semi-aquatic mammals (raccoon, beaver, mink, muskrat, otter) living in the wet bank-to-bank section of perennial flowing rivers and creeks.

[12] Potential risk associated with semi-aquatic mammal consumption is evaluated using the raccoon samples.

[13] Potential risk associated with waterfowl consumption is evaluated qualitatively.

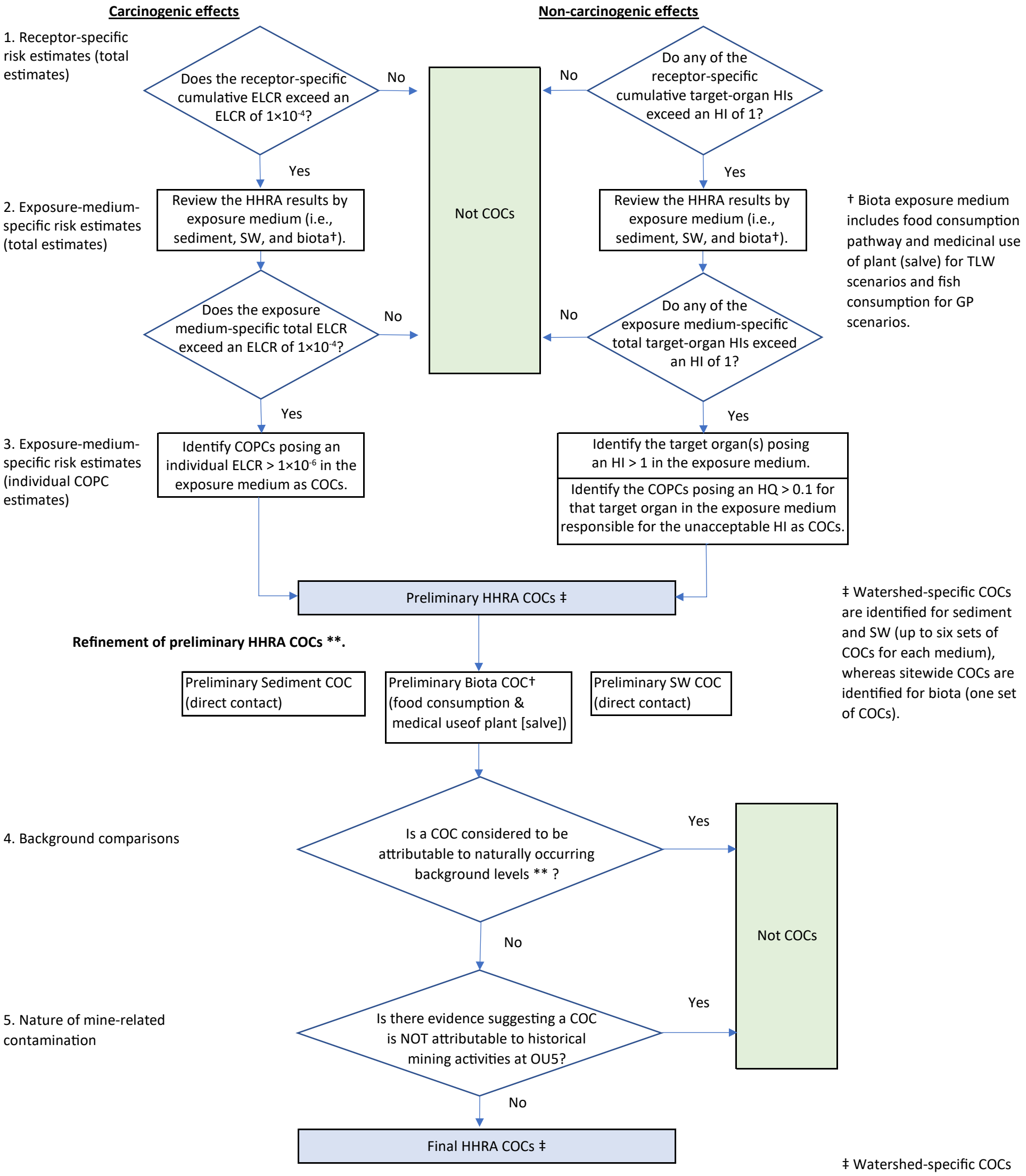
[14] Potential risk associated with aquatic plant consumption is evaluated using the arrowhead and duckweed samples.

[15] Potential risk associated with medical use of aquatic plants is evaluated using the arrowhead samples.

[16] Mine discharge evaluated using the same exposure assumptions as surface water in Appendix F.

Figure 2-3.
Conceptual Exposure Model
Tar Creek Superfund Site
Operable Unit 5 HHRA
Ottawa County, Oklahoma

Identification of HHRA COCs for the TLW and GP exposure scenarios



† Biota exposure medium includes food consumption pathway and medicinal use of plant (salve) for TLW scenarios and fish consumption for GP scenarios.

‡ Watershed-specific COCs are identified for sediment and SW (up to six sets of COCs for each medium), whereas sitewide COCs are identified for biota (one set of COCs).

Acronyms:
COC = Chemical of Concern; COPC = Chemical of Potential Concern;
HHRA = Human Health Risk Assessment; SW = Surface water;
TLW = tribal lifeway; GP = general public

**** General rules to ascertain site is attributable to naturally occurring background levels.**

COCs are NOT considered to be attributable to naturally occurring background levels.

Sediment and biota:	Site > background for both sieved and unsieved datasets.
	Site > background for at least one of the two datasets (sieved or unsieved). Analysis may be performed on the only one of two datasets due to small sample size.
SW:	Site > background (based on total metal dataset).

COCs are considered to be attributable to naturally occurring background levels.

Sediment and biota:	Site is comparable to background for both sieved and unsieved datasets.
	Site is comparable to background for the dataset on which the analysis is performed. Analysis is not performed on the other dataset due to small sample size.
SW:	Site is comparable to background (based on total metal dataset).

Figure 6-1.
Decision Process for Identification of Final HHRA COCs
Tar Creek Superfund Site
Operable Unit 5 HHRA
Ottawa County, Oklahoma

Appendix A
Response to Comments on Interim HHRA Deliverables

Appendix A. Response to Comments on Interim HHRA Deliverables

Introduction

This response to comments (RTC) document addresses comments related to Human Health Risk Assessment (HHRA) for both Tar Creek Operable Unit 5 (OU5) and Tar Creek Operable Unit 4 (OU4). The RTC is a compilation of comments and responses related to three technical documents that have been produced from 2017 to 2019 and issued to interested parties for review and comment prior to submittal of the current draft HHRA report.

The following list identifies each document that was produced, when it was submitted, the parties that provided written comments, and corresponding RTC tables within this appendix.

- **Document No. 1 –** ***Remedial Investigation Report, Version 1.1, Tar Creek Superfund Site Operable Unit 5, Ottawa County, Oklahoma, Task Order No. 079-RICO-06TS, Document Control No. 0079-02013.*** **June 2019.** Submitted to interested parties by EPA via email on July 1, 2019.

  The following parties provided HHRA-related written comments on this document:

  – Abt Associates on behalf of Tar Creek Trustee Council Indian Tribes (TCTCIT) on October 8, 2019 (Table 1a)
  – AESE, Inc., on behalf of Quapaw Nation on October 17, 2019 (Table 1b)
  – Oklahoma Department of Environmental Quality (ODEQ) on October 18, 2019 (Table 1c)

- **Document No. 2 –** ***Technical Memorandum, Human Health Risk Assessment Process, Objectives, and Tribal Lifeways Scenarios Developed for Operable Unit 5, Version 1.2.*** **May 11, 2018.** Submitted to interested parties by EPA via email on May 11, 2018.

  The following parties provided HHRA-related written comments on this document:

  – TCTCIT on June 15, 2018 (Table 2a)
  – AESE, Inc., on behalf of Quapaw Nation on June 18, 2018 (Table 2b[1])
  – ODEQ on July 11, 2018 (Table 2c)

- **Document No. 3 –** ***Draft RAGS Part D Tables (Tables 1-6) for Human Health Risk.*** **Submitted to interested parties by EPA via email. November 14, 2017.**

  The following parties provided HHRA-related written comments on this document:

  – TCTCIT on January 24, 2018 (provided proposed revisions in the Excel file, no written comments)
  – AESE, Inc., on behalf of Quapaw Nation on January 8, 2018 (Table 2b[1])
  – ODEQ on January 8, 2018 (Table 3a)
  – Bureau of Indian Affairs (BIA) on December 13, 2017 (Table 3b)
  – Earl Hatley on January 17, 2018 (Table 3c)
  – LEAD Agency on January 17, 2018 (Table 3d)
  – Larry Tippit/Peoria Tribe of Indians of Oklahoma on January 18, 2018 (Table 3e)

[1] Table 2b contains comments from AESE, Inc., on behalf of Quapaw Nation, for both Documents No. 2 and No. 3.

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Table 1a. Response to Comments Provided by Abt Associates on behalf of TCTCIT on Document No. 1

Item	Section	Page	Comment	Response
2			It is difficult to interpret the data gap investigation when the complete RIR is not presented: This draft of the RIR does not include the HHRA; however, the RIR presents conclusions and generalizations about the HHRA. For example, in Section 3.6 the RIR states: *Despite the challenges meeting the data gap objectives for aquatic biota, there are sufficient quantities of samples to support the HHRA.* (p. 3-14) This statement is difficult to verify without being able to review the HHRA. What analyses has EPA done to support this statement regarding the adequacy of sample size for aquatic biota for the HHRA?	A goal of the RI sampling was to collect supplemental data so that the final dataset provided representative concentrations of aquatic biota that people consume. During the RI, over many field events and various months, it was difficult to find mussels, duckweed, and arrowhead plants to sample due to very limited populations. Tribal input was used to identify potential locations of aquatic plants for sampling. The final datasets are representative of the biota populations present at the time of sampling and are therefore adequate for use in the HHRA.
3			The RIR incorrectly indicates that the scope, conceptual exposure model (CEM), and other aspects of the RIR were "agreed upon" or decided by "consensus" with site stakeholders. a, The RIR states, for example: *The OU5 CEM was defined and agreed upon through resource and literature review, observations from the OU5 CSM, and most importantly, a series of consultations with site stakeholders. Tribal members and citizens input in particular recommended the use of the Quapaw Traditional Lifeways Scenario (Harper, 2008) as the primary basis of formulating the CEM, and the CEM relies heavily upon this resource. In addition, Tribal stakeholders provided valuable input on particular exposure media that are important from both a cultural and dietary consumption standpoint.* (p. 1-2). While it is accurate that the TCTCIT recommended the Quapaw Traditional Lifeways Scenario for use in the CEM, it is not accurate that the TCTCIT agree with EPA's CEM overall. The TCTCIT provided extensive comments on EPA's CEM for OU5 (Abt Associates, 2018), and have yet to receive any response to the comments from EPA. See also comment #4 below regarding inaccurate representations of "consensus" decisions.	Beginning in 2015, input was solicited various times from tribal members and citizens (through AESE/Quapaw Nation and TCTCIT) and the input was used to guide development of the CEM, identify representative biota for sampling, and develop exposure factor values. See Appendix A of the RI report, which summarizes stakeholder engagement activities.

Table 1a. Response to Comments Provided by Abt Associates on behalf of TCTCIT on Document No. 1

Item	Section	Page	Comment	Response
4			Several statements in Section 3.4.3 (Aquatic Plants) are inconsistent with previous TCTCIT comments and recommendations: a, The RIR states: *…consensus was reached on selection of arrowhead root and duckweed as to commonly used aquatic plants that are representative plant species from the seven OU5 watersheds.* (p. 3-8) Although duckweed and arrowhead root are aquatic plant species in the area, analyses in the RIR should not be limited to these species. For example, watercress is another aquatic plant species for which there are available data that could be included in the RIR. Further, we agree that the TCTCIT did previously communicate to EPA that arrowhead root and duckweed are commonly used plants. However, the TCTCIT has never agreed to the notion of limiting data used in the RIR to two aquatic plants. While we understand that EPA was only able to sample a limited number of species due to cost constraints, the TCTCIT believes that all available data, including previously collected data, should be included in the RIR analyses.	Duckweed and arrowhead plants were sampled based on input from the Quapaw Nation and TCTCIT. Both plants are included in the HHRA dataset and are used to represent edible aquatic vegetation in OU5, consistent with discussions held with stakeholders during the HHRA planning stage. The whole arrowhead plant was used to evaluate the salve exposure scenario and ingestion.
5			Some deviations from the field sampling scope during the collection of arrowhead root samples could impact interpretation of the data: Tribal members and citizens consume the upper leaf/stem, the tuber, and the fine roots of arrowhead root. Therefore, EPA intended to collect all three sections of these plants and submit them for analysis. Some specimens were lacking tubers; in these instances, EPA collected the upper leaf/stem and the fine roots. In plants that absorb and hyperaccumulate metal contaminants, the concentrations of the heavy metals may vary between the different parts of the plant. Often, concentrations of contaminants in the roots are greater than concentrations in the leaves (Pullagurala et al., 2018). Tubers also accumulate heavy metals such as lead (Musilova et al., 2015). Plants with tubers present may uptake contaminants at different rates than plants without them; therefore, it may not be appropriate to compare arrowhead root plants with tubers to plants without tubers. This is a concern because it could lead to inaccurate estimates of exposure for locations where plant samples without tubers were collected.	The aquatic plant data were separated by plant part (leaf/stem, tuber, fine roots); metal concentrations in different plant parts are compared and discussed in the uncertainty analysis.

Table 1a. Response to Comments Provided by Abt Associates on behalf of TCTCIT on Document No. 1

Item	Section	Page	Comment	Response
6			EPA was unable to perform moisture content analyses on the 2017 biota samples – all of the tissue data are expressed on a wet-weight (ww) basis: Although ww data are appropriate for analyzing exposure for the HHRA, information regarding the samples' moisture content can help support some analytical decisions. For example, due to limited sampling, EPA is evaluating the plant results as a whole, rather than by plant species. It is important to understand the typical moisture content of each plant species; if the moisture content varies significantly, it is not appropriate to group these species. For example, a plant with a higher moisture content would have a higher dry weight of the contaminant. This is a concern because by grouping the small sample size of plant species that vary greatly in moisture content, EPA could be inconsistently estimating risk across sites.	Metal concentrations in biota samples may differ based on various sample characteristics (not only moisture content but also species, age, sex, and body part, which may be a more important determinant of metal concentrations), but the collected samples were used as a representative of the range of biota that may be consumed over the long-term exposure duration assumed in the HHRA. A discussion of potential impacts on the risk estimates related to use of different parts of biota during food preparation (for fish and aquatic plant) is provided in the uncertainty analysis.
10			Because there is only a small amount of aquatic plant data available in OU5, EPA evaluated the aquatic results as a whole instead of by plant species. How does EPA intend to use these data? Depending on how the EPA plans to use these data, this approach may not be not be satisfactory. As we mentioned above (see comment #9), different plant species uptake contaminants at different rates (Pullagurala et al., 2018). Additionally, the architecture and physiology of duckweed and arrowhead root are very different and may lead to significant differences in concentrations of these species. For example, duckweed plants are simple free-floating plants that lack an obvious stem or leaves, while arrowhead root is more complex with roots, tubers, and well-defined leaves. Duckweed plants were analyzed as a whole, while the leaves, roots, and tubers of the arrowhead root plants were analyzed separately. It is important for us to understand how these data will be used for us to evaluate if EPA's proposed approach is robust. For example, if EPA relies upon average metal concentrations across all plant parts and species for the HHRA, they may underestimate risk to a Tribal member or citizen who consumes mostly roots because, compared to leaves, roots typically contain elevated concentrations of metals.	The aquatic plant data were separated by plant part (leaf/stem, tuber, fine roots) in Appendix F7 and are compared and discussed in the uncertainty analysis.

Table 1b. Response to Comments Provided by AESE, Inc., on behalf of Quapaw Nation, on Document No. 1

Item	Section	Page	Comment	Response
1	Figure 7-3		ARD source omitted. Ingestion, dermal, inhalation needs to be evaluated. Also need irrigation of plants with groundwater/surface water that is mine affected. Plant to cattle to human is omitted. Water to cattle to human is omitted. This CSM needs a major revision.	Acid rock drainage (ARD), in the form of mine discharge, was added as a source to surface water on the CEM. Mine discharge is accessible for contact at two locations, which are conservatively addressed in Appendix F3 using the same exposure assumptions as surface water. Locations where mine discharge enters and mixes with surface water were sampled. Irrigation of plants with surface water that is affected by the mine was added as a potential exposure route on the CEM and is discussed in the HHRA. Plants (arrowhead and duckweed) growing in surface water (which is more exposure than irrigation) were sampled during the RI and associated exposures are addressed in the HHRA. Vegetation (and incidental soil) exposures by grazing cattle (and subsequent human consumption of meat and milk) are terrestrial exposures addressed under Tar Creek OU4 and were further evaluated in the memorandum titled, *Tar Creek Source Material Operable Unit 4 Remedial Action: Results of Bioaccumulation Study of Chemicals of Concern in Row Crop and Pasture Grasses,* prepared by CH2M, dated November 12, 2019; risks were within EPA's acceptable risk levels.

Table 1c. Response to Comments Provided by the ODEQ on Document No. 1

Item	Section	Page	Comment	Response
1			Does EPA plan to use sieved or un-sieved sediment sample data in its risk models. Does EPA plan to use total or dissolved surface water sample data in its risk models?	Both unsieved and sieved sediment data were used in the HHRA. Total metals surface water data were used in the quantitative risk estimates. An evaluation of potential risk based on dissolved metals surface water data is included in the uncertainty analysis of the HHRA.
2			DEQ has concerns about using only one aquatic plant sample as the background reference sample for all aquatic plants in the entire study area and using a dry weight to wet weight conversion factor on this one sample. DEQ would prefer that additional sampling be conducted to increase the sample size for background reference and that those samples be analyzed appropriately so that a conversion factor is not required. This data could be evaluated in the Feasibility Study (FS) stage of the Super-fund Process. In lieu of conducting additional sampling, DEQ requests that EPA include a reference document into the Rl for using the dry to wet weight conversion factor and provide guidance stating that one sample is adequate for background reference.	The background reference concentration in the aquatic plant sample was not used to eliminate COPCs in the HHRA. After the risk estimates were calculated, sediment background comparisons were considered when identifying preliminary COCs in aquatic plants. Because dietary consumption rates are provided on a wet weight basis, all biota datasets used in the HHRA are presented on a wet weight basis. Some of the historical data (e.g., mussels and aquatic plants) were reported as dry weight, and a dry-weight-to-wet-weight conversion was needed to provide consistent reporting format in the dataset. The conversion from dry weight to wet weight was performed using the moisture content of the samples. Chapter 11 of EPA's Exposure Factors Handbook (2011) provides the equation for the conversion.

Table 1c. Response to Comments Provided by the ODEQ on Document No. 1

Item	Section	Page	Comment	Response
3			It appears as if there are different approaches to determining how chemicals of potential concern (COPC) are carried forward in a risk assessment. Although not yet released, the human health risk assessment appears as if it will use BTV (discussed in Section 5 of RI) while the BERA appears to use toxicity threshold values. Is this accurate? If so, why use different approaches?	The background threshold values (BTVs) were not used to identify COPCs. Rather, COPCs for general public direct contact exposure pathways were identified by comparison to EPA's Regional Screening Levels. However, for biota consumption pathways and Tribal Lifeway exposure scenarios, all detected chemicals in a given dataset were conservatively identified as COPCs.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
1	Topic #1a: Consultation process – TCTCIT participation in the consultation process should not be construed as an "endorsement" of EPA's HHRA approach for OU5.	2	The HHRA memo (CH2M HILL, 2018) indicates that EPA has consulted with the nine Tribes in the ongoing HHRA, including, for example, providing documents such as the Remedial Investigation Data Gap Summary Report (CH2M HILL, 2016) for the Tribes for review. We agree that EPA has provided such HHRA work products to the Tribes, in addition to holding periodic check-in teleconferences/meetings, during which EPA has provided general updates to the Tribes on the status of EPA's ongoing HHRA. The TCTCIT appreciate that EPA undertakes these check-ins, consistent with EPA's Indian Policy (Ruckelshaus, 1984; McCarthy, 2014) and trust responsibilities. However, the TCTCIT's participation should not be construed as a blanket "endorsement" of EPA's proposed HHRA approach, and EPA's eventual HHRA results. This is particularly true since some of the main overarching comments and concerns raised by the TCTCIT on the HHRA throughout this government-to-government consultation process have yet to be addressed by EPA (see Topic #4 below).	Comment noted; the exposure scenarios and exposure factor values (and ranges) included in the draft OU5 HHRA prepared by TCTCIT's consultant (Abt Associates) in June 2019 were taken into consideration when developing this HHRA.
2a	Topic #1b: Consultation process – the process should inform, but not be a substitute for, EPA conducting the work needed to delineate RME values.	2	As a part of the HHRA consultation process, EPA has requested information on exposure pathways and levels, and some of the information provided by the TCTCIT has been incorporated into the RME tables in the HHRA memo. In particular, EPA provided the Tribes with draft RME tables via email on November 7, 2017, and requested that the Tribes confirm/review some of the proposed exposure parameters, such as number of days per year and hours per day that Tribal adults and children are exposed to surface water and sediment in OU5. In an effort to facilitate the HHRA process, the TCTCIT technical representatives provided feedback on these values, to the best of their ability and knowledge. However, as communicated to EPA by the TCTCIT in subsequent conversations, including a conference call held on March 16, 2018, the TCTCIT technical representatives do not formally gather, nor do they have access to data on Tribal population exposure metrics, as a part of their respective Tribal departmental duties. Therefore, the provided information should be viewed as estimates that may inform, but should not be a substitute for, whatever process EPA may need to complete to formally and accurately delineate these parameters. This might include consulting with other governmental entities that may gather relevant information, or conducting Tribal population surveys, if needed. For example, EPA guidance on exposure assessment states that site-specific exposure factors can be developed by collecting behavior and activity patterns through surveys, which can be implemented via several methods, including activity diaries and questionnaires (EPA 1992).	Comment noted; the exposure scenarios and exposure factor values (and ranges) included in the draft OU5 HHRA prepared by TCTCIT's consultant (Abt Associates) in June 2019 were taken into consideration when developing this HHRA.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
2b	Topic #1b: Consultation process – the process should inform, but not be a substitute for, EPA conducting the work needed to delineate RME values.	3	We further note that EPA appears to be using values provided by the TCTCIT as inputs for all exposed Tribes. This may not be appropriate, as the TCTCIT includes only seven of the nine Tribes in OU5, and TCTCIT exposure values may not be representative, even as estimates, for the other two Tribes. Finally, in numerous instances, EPA is incorrectly citing the TCTCIT for exposure values in the HHRA memo and accompanying RME tables (see Topic #1c below for further discussion of this topic). EPA should remove reference to the TCTCIT in instances where they are incorrectly cited as the source of information (see Topic #1c), and EPA should complete the work needed to comprehensively delineate exposure parameters, rather than solely relying upon TCTCIT estimates.	Comment noted; the exposure scenarios and exposure factor values (and ranges) included in the draft OU5 HHRA prepared by TCTCIT's consultant (Abt Associates) in June 2019 were taken into consideration when developing this HHRA. Input from the Quapaw Nation and ODEQ was also considered, and the final HHRA exposure scenarios and exposure factor values reflect input from all sources. The reference for each final exposure factor value indicates the source of the value.
3a	Topic 1c: Consultation process – in many instances, EPA's incorporation of information provided by the TCTCIT is inaccurate and EPA incorrectly cites the TCTCIT as the source of numerous exposure parameters.	3	As noted above, EPA circulated draft RME tables via email on November 7, 2017, and requested the Tribes' input on a number of parameters. Also noted above, the TCTCIT do not formally compile the type of requested information (such as the number of days per year that Tribal members and citizens are exposed to surface water and sediment in OU5). However, in an effort to facilitate the HHRA process, the TCTCIT provided EPA with some estimates, based on their existing knowledge of Tribal activities. These values were provided to EPA via email by the TCTCIT on January 24, 2018. It appears that some of this information has been used by EPA in the HHRA memo in a manner that is inconsistent with the TCTCIT's original intent. In other instances, EPA is incorrectly citing the TCTCIT as the source of exposure parameters that the TCTCIT did not provide, or for which the TCTCIT provided a different value. For example:	Comment noted; the exposure scenarios and exposure factor values (and ranges) included in the draft OU5 HHRA prepared by TCTCIT's consultant (Abt Associates) in June 2019 were taken into consideration when developing this HHRA. Input from the Quapaw Nation and ODEQ was also considered, and the final HHRA exposure scenarios and exposure factor values reflect input from all sources. The reference for each final exposure factor value indicates the source of the value.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
3b	Topic 1c: Consultation process – in many instances, EPA's incorporation of information provided by the TCTCIT is inaccurate and EPA incorrectly cites the TCTCIT as the source of numerous exposure parameters.	3, Bullet 1	"Tribal Lifeway" vs "Tribal Worker" scenarios – the TCTCIT estimated that many Tribal adults are exposed to surface water and sediment 312 days/year, through a combination of all activities involving contact with OU5 streams and creeks. This includes fishing, hunting, gathering, ceremonial and other cultural practices, recreating, and work (e.g., hatchery employees who are exposed to OU5 stream water as a part of their daily work duties, or staff from environmental departments who are exposed when collecting environmental samples). The TCTCIT provided this value of 312 days/year to EPA in their January 24, 2018 response to EPA's request. In the HHRA memo, EPA now describes separate "Tribal Lifeway" and "Tribal Worker" exposure scenarios (these separate scenarios did not exist in the November 7, 2017 version of the RME tables). The value of 312 days/year provided by the TCTCIT has been assigned to the "Tribal Lifeway" exposure scenario for the surface water and sediment exposure frequency (see Table 4.2 and page 4/26 of the HHRA memo), and a separate value of 250 days/year is assigned for the "Tribal worker" exposure frequency. The latter value is based on EPA standard exposure factors (see Table 4.3 and page 5/26 of the HHRA memo). This approach raises at least two questions of concern to the TCTCIT: Is EPA intentionally incorporating work-related exposure into both scenarios? Why is a separate "Tribal Worker" scenario needed, if work-related exposure is already incorporated into the "Tribal Lifeway" exposure scenario?	The final exposure frequency for surface water and sediment exposures by Tribal Adults is 312 days/year in this HHRA; this exposure frequency is intended to cover members who (1) work and perform other activities in surface water and sediment outside of work, and (2) do not "work" in surface water but who conduct other Tribal Lifeway activities in or using surface water and sediment. A separate Aquatic Worker scenario is provided to address surface water and sediment exposures by tribal members and citizens who may have minimal surface water or sediment exposure outside of their work exposure. This scenario was also described and emphasized as an important scenario by a TCTCIT entity.
3c	Topic 1c: Consultation process – in many instances, EPA's incorporation of information provided by the TCTCIT is inaccurate and EPA incorrectly cites the TCTCIT as the source of numerous exposure parameters.	4, Bullet 1	Tribal children exposure frequency for surface water and sediment – the TCTCIT estimated that children are exposed to surface water 234 days/year and to sediment 312 days/year in their January 24, 2018 response to EPA. In the HHRA memo RME tables, the exposure frequency for children is set to 244 days/year for both sediment and surface water, and EPA incorrectly sites the TCTCIT for this value (see Tables 4.2 and 4.5, and pages 4/26 and 6/26). Further, EPA states on page 6/26 of the HHRA memo that it is not possible for children to be more exposed to sediment than to surface water because "sediments are below surface water" (page 6/216 of the HHRA memo). The TCTCIT understand that sediments are generally located below surface water. However, the TCTCIT believe it is possible for sediment exposure to be greater than surface water exposure, and would like to clarify that the estimate of 312 days/year includes exposure to sediment that does not involve contact with water. This includes, for example, through contact with sediment-laden clothing and footwear of children's parents, or other sediment-laden items, such as aquatic plants, mussels, etc., collected by family or other members of the community. EPA should remove the TCTCIT as the source for their 244 days/year exposure value in Tables 4.2 and 4.5. We request that EPA reconsider their assertion regarding the impossibility of sediment exposure being higher than surface water exposure for children.	For tribal children, exposure frequencies of 312 days/year (sediment) and 234 days/year (surface water) are used in the HHRA. These exposure frequencies are in addition to evaluation of surface water for potable use and surface water in sweat lodges.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
3d	Topic 1c: Consultation process – in many instances, EPA's incorporation of information provided by the TCTCIT is inaccurate and EPA incorrectly cites the TCTCIT as the source of numerous exposure parameters.	4, Bullet 2	Tribal children swimming and wading event time for surface water and sediment – the TCTCIT estimated that children swim for 6 hours/day and wade for 6 hours/day in their January 24, 2018 reply to EPA. These event times have been set to 1 hour/day and 5 hours/day, respectively, in the HHRA memo (see Table 4.2 and page 4/26 in the HHRA memo). Again, the HHRA memo incorrectly cites the TCTCIT as the source of these values and EPA should remove the TCTCIT as the source for these values. Further, we are concerned that one hour/day does not accurately reflect the duration of children's time swimming (particularly in warmer months, when TCTCIT representatives report that children swim many hours per day each day). However, we acknowledge that we do not have quantitative data on childhood time spent swimming and wading. EPA may therefore need to conduct additional data collection efforts to determine a value for these parameters.	For tribal children, an event time of 6 hours is assumed for a combination of swimming and wading in the HHRA; as a conservative approach, exposure factor values for a swimming scenario are used in the risk estimates to account for a child swimming 6 hours per event.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
3e	Topic 1c: Consultation process – in many instances, EPA's incorporation of information provided by the TCTCIT is inaccurate and EPA incorrectly cites the TCTCIT as the source of numerous exposure parameters.	4, Bullet 3	Exposure to mine discharge – the TCTCIT estimated that adults spend 6 hours/day, 156 days/year; and children spend 1 hour/day, 48 days/year in contact with mine discharge in the information they provided to EPA on January 24, 2018. The HHRA memo states that these exposure times and frequencies were not incorporated into exposure scenarios because EPA believes the TCTCIT was providing estimates of contact with "water bodies that have received mine discharge, rather than direct contact with the shallow mine discharges in the two areas, prior to entering water bodies" (page 8/26 of the HHRA memo). (We note that page 7 of the HHRA memo describes three mine discharge areas, and so we assume the reference to two areas in the quoted text is a typographical error). The TCTCIT would like to affirm that they understand the definition of the term "mine discharge," and the estimates provided by the TCTCIT indeed reflect their estimates for adult and child exposure to the mine drainage areas described in the HHRA memo. These include (1) the area in Commerce, Oklahoma where discharges led to the eventual inclusion of the Tar Creek Superfund Site on the National Priorities List; (2) the area by East 40 Road, where Tar Creek and the old creek bed of Lytle Creek converge; and (3) the area on Beaver Creek, immediately north and south of East 50 Road. However, we acknowledge that these are best estimates, and not quantitative data. EPA may therefore need to conduct additional data collection efforts to determine the value of these parameters.	The mine discharges sampled are representative of those that people could contact outside of creeks, rivers, and tributaries. Mine discharges in one area of the Tar Creek watershed (in Commerce) are currently being treated by passive treatment systems at the point of discharge. The mine discharges within the remaining two areas occur intermittently, have a typically low flow rate, flow over very short distances before reaching a creek, are not wide or deep (typically shallow flow of less than 3 to 5 feet across), and are not easily accessible or are restricted by physical structures such as fences or heavy overgrowth. Although exposure is expected to be infrequent, mine discharge was conservatively evaluated for tribal lifeway hunting/ fishing/gathering and recreational activities (incidental ingestion and dermal contact), tribal lifeway potable use (ingestion and dermal contact), tribal lifeway sweat lodge (ingestion, dermal contact, and inhalation of water vapors), and general public wading (dermal contact) using the same exposure assumptions as surface water in Appendix F3.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
3f	Topic 1c: Consultation process – in many instances, EPA's incorporation of information provided by the TCTCIT is inaccurate and EPA incorrectly cites the TCTCIT as the source of numerous exposure parameters.	5, Bullet 1	The TCTCIT did not provide the ingestion rates for turtles/frogs and for aquatic mammals in Table 4.7 (and discussed on page 7/26 of the HHRA memo), and thus EPA should remove the TCTCIT as the cited source for this information. The TCTCIT did provide the value of 133 g/day for the arrowhead root consumption rate listed in Table 4.7. However, this value is directly derived from the value provided in Harper (2008) for the daily consumption rate for "roots and bulbs." EPA should therefore cite Harper (2008) and not the TCTCIT for this value. Further, when originally providing this value, the TCTCIT did not fully understand the context in which it was to be used. This value represents only a fraction of the total daily plant intake in the Tribal diet described by Harper (2008). In a risk assessment, it is typical to conservatively assume that the total intake of dietary items is from the contaminated source area (see, for example, the HHRA EPA (URS, 2005) conducted for the Midnite Mine Superfund Site). In which case, the daily intake value for plants reported in the HHRA memo and RME tables should be the total plant intake from Harper (2008) of 558 g/day (consisting of legumes, squash and other vegetables, roots and bulbs, greens, and sweets).	The reference for the adult ingestion rate for turtles/frogs, semi-aquatic mammals, and aquatic plants was changed to Harper (2008). This HHRA addresses exposures from the aquatic environment (OU5) only, and not terrestrial sources (OU4). Therefore, the total plant intake from Harper (2008) of 558 g/day (which includes both terrestrial and aquatic sources) is not applicable to OU5.
4	Topic #1d: Consultation process – many of the Tribes are incorrectly identified in the HHRA memo.	5	In general, please correctly refer to the Tribes in communications, and specifically for the HHRA memo, please make the following corrections on page 1/26: • Miami Tribe of Oklahoma (not Miami Nation of Oklahoma) • Seneca-Cayuga Nation (not Seneca-Cayuga Tribe of Oklahoma) • Wyandotte Nation (not Wyandotte Nation of Oklahoma).	The names of the Tribes have been corrected to those indicated in the comment.
5a	Topic #2a: Tribal Lifeways characterization – the characterization of Tribal exposure scenarios in the HHRA memo is confusing and inconsistent across the memorandum and attachments.	5	The HHRA memo describes "Tribal Lifeway," "Worker," and "Sweat Lodge" exposures. However, the relationship between the three is inconsistently described, and it is therefore unclear how the "combined risk" mentioned in the memorandum will be calculated by EPA.	Potential risks associated with each exposure pathway (e.g., ingestion of fish, ingestion of aquatic plants, potable use of surface water) are presented separately. Potential risks associated with aquatic worker exposures are also presented separately. However, cumulative risks from sediment (ingestion and dermal contact), surface water (incidental ingestion, dermal contact, potable use, sweat lodge ingestion, sweat lodge dermal contact, and sweat lodge inhalation), aquatic animal (ingestion), and aquatic plants (ingestion and dermal) exposures are presented to provide a combined risk estimate for OU5 media.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
5b	Topic #2a: Tribal Lifeways characterization – the characterization of Tribal exposure scenarios in the HHRA memo is confusing and inconsistent across the memorandum and attachments.	5, Bullet 1	Section 3 of the HHRA memo (page 3/26) provides a narrative description of the exposure scenarios and is titled "Tribal Lifeway Exposure Scenarios." This section is divided by media and within each media is further subdivided into "Tribal Lifeways Exposures," "Worker Exposures," and "Sweat Lodge Exposure." This structural organization would imply that worker exposure and sweat lodge exposure are subcategories of an overall "Tribal Lifeways Exposure" receptor population.	As presented in the HHRA, a complete "Tribal Lifeway Exposure Scenario" for OU5 consists of potential exposures to sediment (ingestion and dermal contact), surface water (incidental ingestion, dermal contact, potable use, sweat lodge water ingestion, sweat lodge water dermal contact, and sweat lodge water inhalation), aquatic animals (ingestion), and aquatic plants (ingestion and dermal). The adult exposure frequency (312 days/ year) used for sediment and surface water exposures is high enough to account for exposures that may occur at work or while performing Tribal Lifeway activities. A separate "Aquatic Worker" scenario is also presented in the HHRA to address people who work in surface water and sediment (250 days/year) but do not participate in other Tribal Lifeway scenarios.
5c	Topic #2a: Tribal Lifeways characterization – the characterization of Tribal exposure scenarios in the HHRA memo is confusing and inconsistent across the memorandum and attachments.	5, Bullet 2	However, the CEM presented in Attachment one (page 11/26 of the HHRA memo) only shows two Tribal "potential receptor" groups ("Tribal Lifeway" and "Tribal Worker"), and sweat lodges are depicted as an "Exposure Point" (not a receptor). The RME tables in Attachment two (beginning on page 15 of the HHRA memo) similarly list "Tribal Lifeway" and "Tribal Worker" as "Receptor Populations," and sweat lodges as an "Exposure Point."	In the HHRA, sweat lodge exposures are included as part of the Tribal Lifeway scenarios, and include surface water exposures during sweat lodge use (water ingestion, dermal contact with water, and inhalation of steam).

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
5d	Topic #2a: Tribal Lifeways characterization – the characterization of Tribal exposure scenarios in the HHRA memo is confusing and inconsistent across the memorandum and attachments.	6	The TCTCIT recommends that EPA clarify what are considered receptor populations vs exposure points in the HHRA. Further, EPA should clarify the relationship among these exposure populations and, specifically, how EPA intends to determine the "combined risk" (page 3/6 and 11/26 of the HHRA memo), for these exposure groups. Without such changes, the TCTCIT question, for example, how will EPA assess the "combined risk" for a Tribal member or citizen who practices traditional lifeways and also has work-related exposures?	The receptor populations addressed in the HHRA are presented in RAGS Table 1: Tribal Lifeway (adults and children) and General Public (adults and children). Exposure points are indicated in RAGS Table 1 for all media. Potential risks from sediment (ingestion and dermal contact), surface water (incidental ingestion, dermal contact, potable use, sweat lodge ingestion, sweat lodge dermal contact, and sweat lodge inhalation), aquatic animal (ingestion), and aquatic plants (ingestion and dermal) exposures are presented in the HHRA separately and combined to provide a cumulative risk estimate for exposure to OU5 media. Aquatic workers are presented separately to address people who work in surface water and sediment (250 days/year) but may not participate in other Tribal Lifeway scenarios. For those tribal members or citizens who practice traditional lifeways and have work-related exposures, their potential risks are addressed in the Tribal Lifeway scenario.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
6	Topic #2b: Tribal Lifeways characterization – EPA's characterization of Tribal wading and swimming exposure routes is confusing and potentially misleading/inaccurate	6, Para. 1 to 3	The HHRA memo makes statements (page 4/26) regarding the relative frequencies of exposure of Tribal members and citizens engaged in different Tribal Lifeways activities: *Exposure to surface water while wading and swimming consists of both dermal exposure and incidental ingestion. For the purpose of the risk assessment, these exposures for a tribal lifeways scenario with surface water will be evaluated by assessing exposure during wading and swimming activities. Wading and swimming may also occur as a recreational or ceremonial activity, but these exposures are expected to occur at a lower frequency than during hunting and gathering activities, and are therefore addressed by this more conservative exposure scenario. (page 4/26)* Statements are also made in the HHRA memo on pages 5/26 and 6/26 regarding relative frequencies of surface water and sediment exposure during Tribal Lifeway activities: *The tribal lifeways scenario associated with surface water is a conservative representation of many other surface water [sediment] exposures that tribal members and citizens may encounter on a frequent or occasional basis, such as when Entering cold surface water during challenges…Occasional visitors contact surface water during tribal festivals or ceremonies, or recreational activities such as swimming, fishing, or hunting. (page 5/26 and 6/26)* These statements are confusing and the intended significance to the Tribal Lifeways exposure scenario is unclear. We recommend removing the language and replacing with "Tribal members are exposed to surface water and sediment when wading and swimming, which may take place during hunting, fishing, gigging, gathering, ceremonial, and recreational activities that are part of typical cultural practices." Also, EPA should explain or provide sources for the basis of their statements regarding relative frequencies for the different listed Tribal activities. If sources cannot be provided, then these assertions should be removed from the HHRA memo and not incorporated into the OU5 HHRA.	The language referencing these activities has been modified for the HHRA. The HHRA text states that tribal members are exposed to surface water and sediment when wading and swimming, which may take place during hunting, fishing, gigging, gathering, ceremonial, and recreational activities that are part of typical cultural practices.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
7	Topic #2c: Tribal Lifeways characterization – EPA's characterization of Tribal use of plants is confusing and potentially misleading/inaccurate.	7	The HHRA memo states that: *Aquatic plants may also be used for ceremonial practices involving dermal contact or ingestion, but assessment of medicinal use on skin, and direct ingestion of plants as discussed further below, address ceremonial use of plants. (page 6/26)* The HHRA memo then states: *The tribal lifeway scenario associated with aquatic plants is a conservative representation of other aquatic plant ingestion exposures that tribal members and citizens encounter on an occasional basis, such as when ingesting aquatic plants for medicinal purposes. (page 7/26)* Ceremonial and medicinal use of plants should be considered in addition to (not subsumed within) consuming plants as a part of the Tribal diet. EPA should provide the basis (i.e., cite sources) for their statement regarding the "occasional basis" of ingesting aquatic plants for medicinal purposes, and implied relative consumption rates of plants for dietary vs medicinal/ceremonial purposes. If EPA cannot provide a source, these statements should be removed from the HHRA memo and not incorporated into the OU5 HHRA.	Ceremonial and medicinal use of aquatic plants was considered, and potential risks from medicinal use of plants as salve (based on total arrowhead plant data) are included in the HHRA based on the knowledge of use of arrowhead for this purpose. Regarding the statements in the HHRA memo, they will not be included in the OU5 HHRA without sufficient evidence to support the argument.
8	Topic #2d: Tribal Lifeways characterization – EPA's exposure route assumptions for sweat lodge participation should be re-evaluated and adjusted.	7	The HHRA memo states that: *Adults may use a sweat lodge for ceremonial purposes, and the water used in this ceremony comes from surface water, leading to a dermal exposure to surface water. (page 5/26)* Exposure during a sweat lodge ceremony includes inhalation or oral ingestion of water as steam, in addition to dermal contact. In a sweat lodge, water is turned to steam and the participants sit in a steam bath, during which time they are breathing and potentially talking, which means that exposure could be through inhalation or ingestion, in addition to dermal contact. There may also be exposure to sediment during sweat lodge use. EPA should re-evaluate their exposure assumptions and adjust accordingly.	Inhalation, ingestion (1 L/day by adults and children), and dermal contact exposures (whole body) to surface water are included in the HHRA for sweat lodge use.
9	Topic #2e: Tribal Lifeways characterization – the exposure scenarios described in the HHRA memo do not include Tribal use of groundwater springs.	7	Many Tribal members and citizens visit groundwater springs within OU5 to gather plants for consumption (e.g., watercress) and to engage in cultural practices. During these visits, they are exposed via ingestion and dermal contact with the water and sediment. Exposure at groundwater springs should be included in the HHRA.	Groundwater is not a medium addressed under OU5. However, while water from groundwater springs are not specifically addressed in the HHRA, exposures to direct mine discharge are evaluated as a worst-case scenario in Appendix F3.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
10a	Additional details – EPA's body surface area exposure parameter values may underestimate the exposure for both adult workers and children.	8, Bullet 1	Worker skin surface area exposed to surface water and sediment – the HHRA memo states that only the hands and forearms of workers come into contact with surface water and sediment (see pages 5/26 and 6/26 of the HHRA memo). The TCTCIT understand from conversations with Tribal workers that this is not necessarily true. Tribal workers normally wear protective gear when in contact with surface water and sediment, but the nature of the work can be variable and it is common to have contact with water and sediment on the face, legs, and sometimes body as a result of normal work conditions in the field. Figure 1 provides an illustration of this point, showing Tribal hatchery workers directly exposed up to their chests to surface water and sediments pumped from the Spring River. Therefore, it would be appropriate to expand the exposed skin surface area for workers to ensure that the HHRA estimates are protective of all Tribal community members. This would affect the "skin surface area available for contact" parameter in Tables 4.3 and 4.6.	It is conservatively assumed in the HHRA that an aquatic worker has their entire body exposed to surface water and sediment every work day (250 days/year) for 25 years.
10b	Additional details – EPA's body surface area exposure parameter values may underestimate the exposure for both adult workers and children.	8, Bullet 2	Child skin surface area exposed to surface water and sediment when wading – the HHRA memo assumes that when wading, children's hands, forearms, lower legs, and feet are exposed to surface water and sediment. This may be an underestimate of the portions of the body that get wet and come into contact with sediment, particularly for young children (up to 6 years). It may be appropriate to expand the exposed skin surface area to the "total skin area" used for swimming for this age group. This would affect the "skin surface area available for contact" parameter in Tables 4.2 and 4.5.	It is conservatively assumed in the HHRA that a tribal child has their entire body exposed to surface water and sediment during every swimming/wading event.
11a	Topic #3b: Additional details – there are minor unexplained numerical discrepancies between the HHRA memo and the November 7, 2018 version of the RME tables.	8, Bullet 1	Text on page 15/26, Table 4.1: Adult dermal contact is identified as 0.72 hours/event. This value is slightly different than the value in an earlier version of the RME tables that EPA shared with the TCTCIT via email on November 7, 2017 (previous estimate was 0.71 hours/event). What is the reason for this slight difference?	The HHRA uses a water dermal contact event time of 0.71 hour/event for adults, which is the default value provided by EPA for daily potable water dermal contact.
11b	Topic #3b: Additional details – there are minor unexplained numerical discrepancies between the HHRA memo and the November 7, 2018 version of the RME tables.	8, Bullet 2	Text on page 16/26, Table 4.1: Child dermal contact is identified as 0.53 hours/event. This value is slightly different than the value in an earlier version of the RME tables that EPA shared with the TCTCIT via email on November 7, 2017 (previous estimate was 0.54 hours/event). What is the reason for this slight difference?	The HHRA uses a water dermal contact event time of 0.54 hour/event for children, which is the default value provided by EPA for daily potable water dermal contact.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
12	Topic #3c: Additional details – incorrect spelling of Tribal activities.	8	On pages 5/26 and 6/26, under "Applicability of Evaluated Exposure Scenarios to Other Surface Water (Sediment) Scenarios," the HHRA memo lists "*Jigging or spearing fish….*" We believe this is a typographical error that should be corrected to "*Gigging or spearing fish….*"	The spelling of "gigging" is correct in the HHRA.
13	Topic #4a: Overall nature and extent – the HHRA may underestimate the risk if cumulative effects across multiple exposure pathways and multiple contaminants are not adequately characterized.	10	The HHRA memo indicates, "The HHRA will present exposure and risk estimates for each sampled medium separately and will also provide risk estimates for all exposure media (surface water, sediments and aquatic biota) and pathways combined at OU5" (page 11/26 of the HHRA memo). However, EPA does not describe how they intend to assess risk from all pathways combined. Further, EPA does not describe how the HHRA will address the combined risk associated with the multiple metal contaminants that are present within OU5. It is therefore difficult for the TCTCIT to evaluate the adequacy of EPA's "combined" approach for all exposure media and pathways, and whether EPA intends to assess cumulative risk. EPA (U.S. EPA, 2003) defines cumulative risk as the combined risks from aggregate exposures to multiple agents or stressors, and further states that: *this definition requires that the risks from multiple agents or stressors be combined. This does not necessarily mean that the risks should be "added," but rather that some analysis should be conducted to determine how the risks from the various agents or stressors interact. It also means that an assessment that covers a number of chemicals or other stressors but that merely lists each chemical with a corresponding risk without consideration of the other chemicals present is not an assessment of cumulative risk. (U.S. EPA, 2003, p.17)* The description of EPA's HHRA approach for OU5 is incomplete because it does not adequately describe how cumulative risk will be determined, particularly given the multiple contaminants present at this site.	The HHRA provides cumulative risk estimates assuming additivity for chemicals with the same target organ. The HHRA presents cumulative risk estimates for each exposure scenario, based on risks from surface water and sediment in each waterway separately and combined watershed-wide risks from biota consumption. To understand potential vulnerability of communities around Tar Creek Superfund Site, a discussion of demographic data (as indicators of additional stressors) in these communities will be included in the HHRA.
14	Topic #4b: Overall nature and extent – underestimation of risk – the HHRA may underestimate risk due to the inadequate consideration of "background" contaminant exposure levels.	10-11	The TCTCIT has previously commented on this topic [see, for example, Abt Associates (2016)]. The HHRA is focused on OU5, which consists of surface water and sediment located downstream of mined areas. Because of this focus, EPA is only considering exposure to contaminants through dermal contact and ingestion of surface water, sediments, and aquatic biota within OU5. However, members and citizens of the TCTCIT are not only exposed to metal contaminants of the Tar Creek Superfund Site through these exposure pathways. TCTCIT members and citizens also engage in other activities that may expose them to these metals. For example, they may be exposed while gathering and ingesting terrestrial plants, and while hunting and ingesting big game in other parts of the Tar Creek Superfund Site. By not taking into account these other "background" contaminant exposure pathways and levels, EPA may over-estimate levels that are considered "safe" within OU5, which may ultimately lead to cleanup levels that are not protective of human health.	EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988) indicates that when a site is divided into operable units (OUs), a risk assessment should be performed for each unit separately. During the remedial alternatives process, the alternatives should be evaluated to ensure that they protect human health and the environment from each potential pathway of concern at the site or those areas of the site being addressed as part of an OU.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
			Disregarding other sources of contaminant exposure and contaminant background levels when assessing risk and setting "safe" exposure levels is at direct odds with EPA's own risk assessment guidance. For example: EPA guidance for metals risk assessment, children's risk assessment, and for setting safe consumption limits indicate that, to properly address the risk of a contaminant to human health, assessors need to consider all exposure sources in their assessments (U.S. EPA, 2000a, 2000b, 2007). EPA's *Framework for Metals Risk Assessment* states: *In Exposure Assessment, the risk assessor quantifies the total exposure to a toxic agent in the environment based on amount taken into the body, including any combination of the oral, inhalation, and dermal routes of exposure* (U.S. EPA, 2007, p. 4-1). EPA guidance is clear that when establishing safe consumption levels, a comprehensive evaluation of all sources of exposure should be conducted (U.S. EPA, 2000a). For example, when setting fish consumption advisories (FCAs), EPA states that it is important to consider all exposure routes because even though exposure through the consumption of fish alone may be safe, the total exposure to a contaminant, when including sources other than the fish, may cause an individual to exceed a safe exposure level, thus requiring issuance of an FCA (U.S. EPA, 2000a). EPA's guidance for deriving ambient water quality criteria (AWQC) also recommends considering all sources of exposure when assessing risk, by applying a relative source contribution (RSC; U.S. EPA, 2000b). The 2015 AWQC update recommends the inclusion of an RSC ranging from 20% to 80%, to account for contaminant exposure from other sources, including food consumption (e.g., meats, poultry, fruits, vegetables, grains), dermal exposure, and respiratory exposure (U.S. EPA, 2015). While the AWQC is obviously focused on water criteria, the guidance includes broader statements about EPA-wide policy on characterizing exposure and human health risk. Throughout this guidance, EPA stresses that assessors should consider all sources of contaminant exposure when evaluating human health risk, and states that this approach is an Agency-wide priority: *The policy of considering multiple sources of exposure when deriving health-based criteria has become common in EPA's program office risk characterizations and criteria and standard-setting actions. Numerous EPA workgroups have evaluated the appropriateness of factoring in such exposures, and the Agency concludes that it is important for adequately protecting human health* (U.S. EPA, 2000b, p. 4-4). Even if risk assessors focus on a particular exposure scenario, EPA guidance is clear that assessors need to characterize all "background" exposure values and include them in the assessment (U.S. EPA, 2003, 2007). Within this context, EPA defines "background" as all existing metal sources other than the targeted source. Therefore, even if EPA is focusing their HHRA on aquatic exposure pathways within OU5, they still need to consider other "background" sources of exposure, which for Tribal members and citizens in OU5	If separate alternatives have been developed for different areas or media of the site, it is recommended that they be combined during the detailed analysis phase to present comprehensive options addressing all potential threats posed by the site or that area being addressed by the OU. EPA's *Risk Assessment Guidance for Superfund (RAGS) Part A* (EPA, 1989) states: "The human health evaluation should focus on the subject of the RI/FS [remedial investigation/feasibility study], whether that is an operable unit or the site as a whole. The baseline risk assessment and other risk information gathered will provide the justification for taking the action for the operable unit. At the same time, personnel involved in conducting the human health evaluation for a focused RI/FS must be mindful of other potential exposure pathways, and other actions that are being contemplated for the site to address other potential exposures. Risk analysts should foresee that exposure pathways outside the scope of the focused RI/FS may ultimately be combined with exposure pathways that are directly addressed by the focused RI/FS. Considering risks from all related operable units should prevent the unexpected discovery of high multiple pathway risks during the human health evaluation for the last operable unit." The HHRA risk estimates address potential exposures to media within OU5 only. The risk estimates associated with terrestrial exposures were presented in the HHRA for OU4.

Table 2a. Response to Comments Provided by TCTCIT on Document No. 2

Item	Section	Page	Comment	Response
			include, for example, contaminated air and soil, large game, small game, and terrestrial plants in other parts of the Tar Creek Superfund Site. If EPA does not consider these sources, EPA may underestimate the risk and set exposure and cleanup levels that are in fact not protective of human health.	The approach for development of preliminary remediation goals (PRGs) and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level), including considerations for other OUs, have not yet been established and will be developed after the HHRA for OU5.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
1	Introduction	1 Para. 2 and 3	The Quapaw Tribe of Oklahoma (QTO) provided comments on an earlier supporting document (Attachment No 1). The majority of concerns raised in this previous review still are unresolved. The QTO believes it would be much more expeditious and cost-effective for EPA to respond to these previous concerns (Attachment No. 1) as well as additional concerns provided herein before proceeding any further. The QTO reiterates that OU4-specific cleanup standards/goals have been developed without considering risk associated with the use of the other OUs. Remediation/removal in OU4 has proceeded relying on these values. Having this concern in 2015, made the Tribe realize that in order to save time and resources, we needed to develop a Reasonable Maximal Exposure Scenario (RME) for each OU as soon as possible.[1] As demonstrated below, the information contained in this technical memorandum falls far short. [1] In early 2016 the Tribe proposed to EPA to develop RME's for each OU type; however, funding was not received.	The HHRA risk estimates address potential exposures to media within OU5 only; the RME exposure scenarios and assumptions are based on input received from the QTO and TCTCIT. The risk estimates associated with terrestrial exposures were presented in the HHRA for OU4. The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.
2	General Comments (in addition to those raised in Attachment No. 1)	2, Bullet 1	Aquatic-based and terrestrial-based variants of the RME for the QTO need to be developed as soon as possible (see Attachment No. 1)	The HHRA risk estimates address potential exposures to media within OU5 only; the RME exposure scenarios and assumptions are based on input received from the QTO and TCTCIT. The risk estimates associated with terrestrial exposures were presented in the HHRA for OU4.
3	General Comments (in addition to those raised in Attachment No. 1)	2, Bullet 2	From data presented in the Tech Memo, it is clear that the Tribes of the Tar Creek Trustee council (TCTC) rely on resources at much lower consumption rates, frequencies, and durations. Therefore the QTO is greatest exposed hedonistic receptor in the area. This means that tribes of the TCTCIT are much lower risk populations and should not be the subject of development of RMEs, since the QTO RME (terrestrial and aquatic variants) is protective of the TCTCIT Tribes. This also means that PRGs/RAOs and ultimately selection of the preferred alternative must be based on the QTO RME and not RME based on the TCTCIT tribes.	The final biota consumption rates used in the HHRA were obtained from Harper (2008) (see RAGS Table 4.6). The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
4	General Comments (in addition to those raised in Attachment No. 1)	2, Bullet 3	The General Objectives of the Tar Creek OU5 HHRA (Section 2.0) is misleading: *The objectives of the HHRA are two-fold: first, to estimate the level of risk to human health associated with concentrations of environmental contaminants detected in OU5 media (surface water, sediments, biota, and mine discharge);* At this stage of the RI/FS, estimating PRGs/RAOs is the objective, followed by quantification of residual risk associated with each proposed alternative in the FS. The Hazard Ranking Score (HRS) has already demonstrated that Risk is excessive, even to the general public. Risk is clearly much greater for the QTO who "live close to the land". *Risks are estimated **for current exposures to OU5** media as well as reasonably foreseeable future uses. All contaminated media within OU5 are considered (such as sediment and surface water) if individuals are likely to be exposed to the media. All relevant **routes of exposure for OU5 are considered**, including direct contact (ingestion and dermal exposure) and indirect contact (exposure to food items that have accumulated contaminants through sediments).* [Emphasis added] EPA cannot discount risk associated with the other OUs. In other words EPA needs to assess risk allocation from all OUs, from all COCs released, from all media, along all pathways to the QTO.	EPA's *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (EPA, 1991) indicates that the primary purpose of the baseline risk assessment is to provide risk managers with an understanding of the actual and potential risks to human health and the environment posed by the site and any uncertainties associated with the assessment. The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.
5	General Comments (in addition to those raised in Attachment No. 1)	3, Bullet 4	Sweatlodge usage was intentionally left ambiguous in the original QTO HHRA Scenario. The Traditional QTO frequency of sweatlodge use requires more research. This was included in the aforementioned proposal mentioned in Attachment No. 1. The downriver tribes may use a sweat lodge less than once per month, but research may reveal that the QTO use it at a higher frequency. This is important because the QTO reservation encompasses the most contaminated lands of all OUs.[2,3] The QTO are the population representing the RME, and sweatlodge use is likely an important risk-driving activity. This means that PRGs/RAOs and subsequent remedies will be based on remedies that are protective for the Quapaw Tribe. [2] The Tribe also has the right to hunt fish and gather in areas downstream of their reservation. [3] Many of the QTO members are dual citizens or have relatives of the downstream tribes that would result in the QTO to be exposed via diet during hunting, fishing, and gathering or via trade of contaminated resources.	A sweat lodge exposure frequency of 365 days/year, exposure time of 1 hour/event, and exposure duration of 64 years is used for adults in the HHRA based on *Shoshone-Bannock Exposure Scenario for Use in Risk Assessment: Traditional Subsistence Lifeways*. (S-B EWMP, 2016). These exposure assumptions are more conservative than input provided by Quapaw and TCTCIT. A sweat lodge exposure frequency of 365 days/year, exposure time of 1 hour/event, and exposure duration of 4 years (children ages 2 to 6) is used for children in the HHRA based on input from QTO since TCTCIT indicated that children do not use the sweat lodge.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
6	General Comments (in addition to those raised in Attachment No. 1)	3, Bullet 5	The distinction between ordinary surface water and mine discharge surface water is not clear. *"Mine discharge occurs in three known locations of the Tar Creek Superfund Site in Ottawa County, Oklahoma"* It is not clear why there is any distinction at all, since any mine discharge becomes diluted with other water, and at some magical undefined point becomes ordinary surface water. The standard RME should be applied to these locations just as with any other location. This approach should save on risk calculation costs as well. Also, water quality standards are not dependent on the depth of the water (Section 3.4). The mine water media also needs to be connected to Surface Water in the wire-frame CSM.	The mine discharges sampled are representative of those that people could contact outside of creeks, rivers, and tributaries. Mine discharges in one area of the Tar Creek Watershed (in Commerce) are currently being treated by passive treatment systems at the point of discharge. The mine discharges within the remaining two areas occur intermittently, have a typically low flow rate, and are not easily accessible. Although exposure is expected to be infrequent, mine discharge was conservatively evaluated using the same exposure scenarios and assumptions as surface water in Appendix F3. Mine discharge media is connected to surface water in the conceptual site model (CSM) figure provided in the HHRA.
7	Specific Comments	4, Bullet 1	Section 1.0(1). While there is a logic to start by collecting all available data and then filling data gaps, a more complete process would be to: (Step 1) develop a whole-site human usage map and exposure scenario (the "exposome"), (Step 2) develop DQOs with detection limits based on total exposure and on background , (Step 3) review existing data for data usability according to EPA guidelines, (Step 4) develop a data gap report, (Step 5) collect new data, (Step 6) determine how to allocate risk among OUs and develop RMEs for as many OUs or sub-site areas as needed, and (Step 7) evaluate exposure and risk. These earlier documents cannot exist, since the RME(s) have not been developed and they are necessary to developing OU-specific DQOs and subsequently determine data usability. The allocation of risk among OUs means that the total allowable human risk (e.g., 1E-6 and HI = 1) will need to be subdivided among OUs so that individual OUs do not usurp the entire risk budget. Risk targets for individual OUs will need to be fractions of the total allowable risk. This comment is expanded in the next comment.	This HHRA addresses potential exposures to media within OU5 only. The risk estimates associated with terrestrial exposures were presented in the HHRA for OU4 and residential exposures in the HHRA for OU2. The preliminary CSM was developed at the beginning of the OU5 study in 2016 and continued to be refined with input from QTO and TCTCIT, and has informed the OU5 HHRA. Step 1 is not necessary as each OU has allocated risk (Step 6) and each OU has completed Steps 2 through Step 7. The RME for OU5 scenarios and exposure assumptions were identified through input from TCTCIT and QTO. The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
8	Specific Comments	4, Bullet 2	The "Overview of the Superfund HHRA Process" is incorrect. *1. The first step focuses on data collection and analysis to evaluate the characteristics of the site and support identification of the chemicals of potential concern (COPCs) in site media.* This step is performed prior to listing in HRS and only identifies gross COPCs detrimental to the general public. The HHRAS/RME is required to determine necessary detection limits of COPCs. However, since Tribal populations use are the greatest exposed hedonistic receptor in the area, generally for mine sites, all EPA Target Analyte List (plus molybdenum) are COCs and the list of TAL+Mo cannot be screened-down. Regardless, COCs, necessary detection limits, and geographic scope are determined near Step 4. Data gaps cannot be determined until EPA knows what data are needed (DQOs) and if the exiting data meet these DQOs. A later step is developing the SAP/FSP (or similar document(s)) that provides statistical design-level rationale for sampling biotic and abiotic media identified by EPA to be lacking from the historic database at the proper risk-based detection levels. This lacking information is termed data gaps. In order to determine what data are missing, EPA must first know what data they need to perform the BHHRA. The BHHRA is based on the reasonably anticipated future land use (RAFLU) of the target population. Note that land use is determined by the land owner first, and then the area is cleaned up to make that use safe, rather than forcing land use to be limited if the cleanup is not sufficient to reduce risk enough based on the RAFLU (i.e., if institutional controls are needed). At TC, since these are Tribal lands, the QTO is the target of the BHHRA. Once the RAFLU and the target population have been identified, a plan is developed that specifies the data needs for the BHHRA. This is done in the HHRA work plan by using the conceptual site model as a visual accounting tool to derive the list of data that are needed. Next, the quality and quantity of those data are defined in a similar manner while the data quality objectives are being prepared. Once the DQOs have been prepared, the DQOs are used as a screening tool to evaluate the historical data. Data that meet the DQOs are retained for the BHHRA. Data that do not meet the DQO's are rejected and the data gap is recorded. Finally, a SAP and a FSP are developed using the DQOs and the HHRA WP to fill the gaps. This approach is detailed in the NCP.	The first step of the baseline HHRA process, as presented in EPA's RAGS Part A, is Data Evaluation, which includes screening site data for chemicals exceeding risk-based concentrations. The chemicals exceeding screening levels are termed chemicals of potential concern (COPCs), and those that are risk drivers based on the HHRA results are termed chemicals of concern (COCs). The data usability evaluation that was conducted on the existing dataset in 2016 is documented in the Data Gap Summary Report (CH2M, 2016). The data that were concluded to be usable for the HHRA have been incorporated into the HHRA dataset. Significant historical studies and associated datasets have focused on only cadmium, lead, and zinc. New data gap samples were analyzed for all metals, not an abbreviated list. The analyte list and the detection limits needed from a risk-based standpoint were identified in the Quality Assurance Project Plan (2017), which included the data quality objectives (DQOs). The HHRA evaluates a Tribal Lifeway scenario in OU5. The preliminary CSM was developed at the beginning of the OU5 study in 2016 and continued to be refined with input from QTO and TCTCIT. The exposure scenarios and assumptions were identified with input from QTO and TCTCIT.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
9	Specific Comments	5, Bullet 3	Exposure parameters do not have "conservative safety factors" (Section 1.0(2)). *….These assumptions, or default values, are assumed to be representative of a population, although they often include a conservative safety factor. These parameters include things such as time spent contacting surface water.* Exposure factors for the general population are based on actual data and statistical analysis, aiming at central tendency or upper percentiles, depending on the exposure pathway. For unstudied populations, the exposure parameters are extrapolated from actual data with professional judgment. A "reasonable maximum" is exactly that, reasonable.	The specific section of the Technical Memorandum cited in the comment was a general discussion of the Superfund HHRA process. In the HHRA for OU5, the exposure scenarios and assumptions for the Tribal Lifeway scenarios were identified with input from the Quapaw Nation and TCTCIT.
10	Specific Comments	5, Bullet 4	An ecological determination of water body types (and therefore the specific boundaries of OU5) will probably be needed, because the sampling locations appear to include wetlands, streams, rivers, lakes, and springs. Perhaps the boundary of OU5 is a high water mark for a lake, but how is the boundary determined for a wetland or floodplain with seasonal discharges?	OU5 is defined as the wet-bank-to-wet-bank boundaries of perennial flowing streams. Wetlands and riparian areas were included in OU4. All samples used in the OU5 HHRA were collected within the OU5 study area and specifically within the wet-bank-to-wet-bank boundaries of the perennial flowing creeks, with limited exception to select biota such as frogs and raccoons.
11	Specific Comments	5, Bullet 5	The relation between OU5 and the other OUs or other exposure areas is not clear. The floodplains are not included in the OU5 consideration. This is a systemic problem with the approach of subdividing a superfund site into OUs. While remedies may occur as separate engineering actions (e.g., pump and treat groundwater, excavate soil, cap sediments), the human body integrates all media, pathways, and contaminants into one cumulative set of doses with one single physiological response. A truly cumulative approach does not set a remedy for one medium at a time, or one OU at a time unless the contributions from ALL OTHER media, pathways, chemicals, and OUs is treated as background exposures (the RSC or relative source contribution approach). Otherwise, 100% of exposure and risk must be assumed to be derived from each individual OU, and no exposure can occur from other OUs. As currently envisioned, for OU5 100% of time and exposure and food must come from OU5. The only alternative to this is to allocate risk among OUs, such as allowing OU5 to contribute only 20% of the total risk, thus requiring, for instance, the total hazard index (summation of HQ's) from all COCs to be 0.2, not 1.0.	EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988) indicates that when a site is divided into OUs, a risk assessment should be performed for each unit separately. During the remedial alternatives process, the alternatives should be evaluated to ensure that they protect human health and the environment from each potential pathway of concern at the site or those areas of the site being addressed as part of an OU. If separate alternatives have been developed for different areas or media of the site, it is recommended that they be combined during the detailed analysis phase to present comprehensive options addressing all potential threats posed by the site or that area being addressed by the OU.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
				EPA's *Risk Assessment Guidance for Superfund (RAGS) Part A* (EPA, 1989) states: "The human health evaluation should focus on the subject of the RI/FS, whether that is an operable unit or the site as a whole. The baseline risk assessment and other risk information gathered will provide the justification for taking the action for the operable unit. At the same time, personnel involved in conducting the human health evaluation for a focused RI/FS must be mindful of other potential exposure pathways, and other actions that are being contemplated for the site to address other potential exposures. Risk analysts should foresee that exposure pathways outside the scope of the focused RI/FS may ultimately be combined with exposure pathways that are directly addressed by the focused RI/FS. Considering risks from all related operable units should prevent the unexpected discovery of high multiple pathway risks during the human health evaluation for the last operable unit." The HHRA risk estimates address potential exposures to media within OU5 only; floodplains were addressed as riparian areas in the OU4 HHRA. In the OU5 HHRA, the following is assumed: • All sediment and surface water exposures occur within OU5. • All drinking water and sweat lodge water is obtained from surface water in OU5. • All fish and shellfish food (100% of the "aquatic and fish" food category in Harper [2008]) is from OU5.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
				• All small game food (135% of the "small game" food category in Harper [2008]) is from OU5. • All roots and bulbs food (100% of the "roots & bulbs" food category in Harper [2008]) is from OU5. • All plants used for salve (45 days/year) are from OU5. The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.
12	Specific Comments	6, Bullet 6	The body weight of 80 kg is acceptable only if all the dietary intake values are adjusted upward (See General Comment 3, Attachment No. 1). There are several ways to calculate this. A simple way is to multiply body weight (pounds) by 15-16 kcal/pound to maintain body weight.[4] The Harris-Benedict formula is based on total body weight, height, age, and sex and is a more accurate way to calculate basal metabolic rate. Men: BMR = 66 + (13.7 x wt in kg) + (5 x ht in cm) - (6.8 x age in years), Women: BMR = 655 + (9.6 x wt in kg) + (1.8 x ht in cm) - (4.7 x age in years). The BMR is then multiplied by a factor that considers the activity level of the person:·Sedentary = BMR x 1.2 (little or no exercise, desk job), Lightly active = BMR x 1.375 (light exercise/ sports 1-3 days/week). Moderately active = BMR x 1.55 (moderate exercise/ sports 6-7 days/week). Very active = BMR x 1.725 (hard exercise every day, or exercising 2 xs/day). Extra active = BMR x 1.9 (hard exercise 2 or more times per day, or training for marathon, or triathlon, etc. A similar approach is taken by the University of Maryland.[5] Men who are moderately active should multiply their weight in pounds by 15; women multiply by 12. The resulting number is the total calories per day needed to maintain weight. Relatively inactive men should multiply their weight by 13 and women, by 10. A moderately active woman who weighs 150 lbs. would need 1,800 calories per day to maintain her weight. The US Department of Health and Human Services provides age-specific guidelines in their publication, "Dietary Guidelines for Americans, 2015-2020, 8th edition. [6] For use in this RME, a single simplified value of 2200 kcal/day will be used, for a lightly active to moderately active lifestyle. Note again that, based on the original QTO scenario, the aquatic ecosystem provides only 22% of total food. If OU5 is allowed to contribute 100% of allowable exposure and risk, then none of the other food can come from any other OU, and the person or family cannot live in those OUs and come into contact with them.	A body weight of 70 kg for Tribal Lifeway adults is used in the HHRA, consistent with the *Quapaw Traditional Lifeways Scenario* (Harper, 2008).

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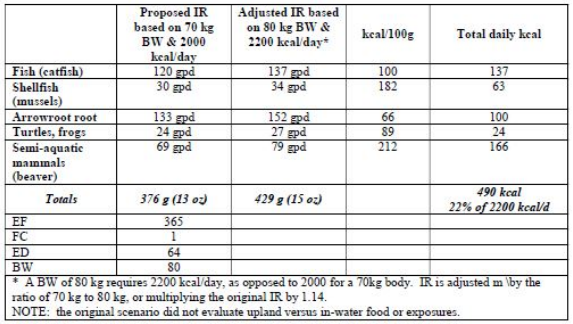
Item	Section	Page	Comment	Response
				
13	Specific Comment	7, Bullet 7	The rationale for the values in the separate document TCTC_RAGS_Table 4 from 2016 are not clear from the footnotes. For example, the Tribes proposed a shellfish IR of 30 gpd, while the proposed value was 12 gpd (not converted to g/kg-d), and the Tribes' IR for plants is 133 gpd while the proposed value was 40 gpd. The rates in the TCOU5RI (the current document under review) no longer have the lower proposed values, so please verify that the older RAGS_Table 4 table is no longer the operative table. Again, the QTO is the RME in which PRGs/RAOs must be based. Comments provided by the TCTC demonstrate that that Tribes belonging to this entity are less likely to be exposed, even in the downstream areas than the QTO7 (Also See Comment No. 5 Attachment No. 1).	The final values for biota ingestion rates are presented in RAGS Table 4.6; as shown, the shellfish ingestion rate is 30 g/day for adults. The final values for plant ingestion rates are presented in RAGS Table 4.7; as shown, the ingestion rate is 133 g/day for adults.
14	Specific Comment	8, Bullet 8	The tribal worker scenario is not a useful scenario for two reasons. First, the tribal worker is assumed to spend fewer days per year (250 days) than the resident (312 days), and a shorter exposure duration (25 versus 70 years). It is not clear why the tribal worker's exposure is less than the ordinary resident. The only difference is that the skin surface might be reduced if the worker wears waders, but this difference alone seems unnecessary. Second, if the tribal worker's allowable risk is set at 1e-6 and HI=1, then this worker must live somewhere else, retire somewhere else, he cannot eat fish from the lake with his family members, and he cannot use the sweatlodge. It is more realistic that a regular tribal resident also works on the remedy, which does not change the total exposure in the scenario as described now.	Aquatic workers are presented separately to address people who work in surface water and sediment (250 days/year) but do not participate in other Tribal Lifeway scenarios (i.e., they may not practice in sweat lodge ceremonies or other Tribal Lifeway scenarios, thus their RME comes from being an aquatic worker exposed to surface water and sediment while working).
15	Specific Comment	8, Bullet 9	Please remove the term "conservative" throughout the document and substitute the work "reasonable". The RME is reasonable, not a conservative worst case. For example, Section 3.1.4 says both that the RME does not include special high-contact water events but implies that it still over-estimates total reasonable exposures. It would be more appropriate to say that the reasonable maximum may not include certain high-contact events; those events might not need to be addressed in a risk assessment, but special advice to members depending on exposure point concentrations might be warranted.	The wording in the HHRA indicates that the RME scenario may not include certain high-contact events.

	Proposed IR based on 70 kg BW & 2000 kcal/day	Adjusted IR based on 80 kg BW & 2200 kcal/day*	kcal/100g	Total daily kcal
Fish (catfish)	120 gpd	137 gpd	100	137
Shellfish (mussels)	30 gpd	34 gpd	182	63
Arrowroot root	133 gpd	152 gpd	66	100
Turtles, frogs	24 gpd	27 gpd	89	24
Semi-aquatic mammals (beaver)	69 gpd	79 gpd	212	166
Totals	*376 g (13 oz)*	*429 g (15 oz)*		*490 kcal 22% of 2200 kcal/d*
EF	365			
FC	1			
ED	64			
BW	80			

* A BW of 80 kg requires 2200 kcal/day, as opposed to 2000 for a 70kg body. IR is adjusted m \by the ratio of 70 kg to 80 kg, or multiplying the original IR by 1.14.
NOTE: the original scenario did not evaluate upland versus in-water food or exposures.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
16	Specific Comment	8, Bullet 10	Section 3.1.1 The consideration of salve is good. It is not clear if any other aquatic plants will be sampled, or whether arrowroot represents all edible aquatic vegetation.	Duckweed and arrowhead plants were sampled based on input from QTO and TCTCIT. Both plants are included in the HHRA dataset and are used to represent edible aquatic vegetation. All parts of the arrowhead plant were used to evaluate the salve and ingestion exposure scenarios.
17	Specific Comment	8, Bullet 11	Section 3.3.2, Fish and shellfish ingestion. See comment on adjusting the intake rate. When the actual risk assessment is done, more attention to the method of preparation of various species may be needed, such as a crayfish boil, fish served skin on or off, and so on. A similar comment pertains to aquatic plants and how much sediment might remain on them (relevant to collection and sampling methods as well as to risk estimation).	A body weight of 70 kg was used for Tribal Lifeway adults in the HHRA, so no adjustment was needed for the intake rate. Based on input from QTO and TCTCIT, three types of fish samples were analyzed: head only, fillet only, and eviscerated carcass (the eviscerated whole body was calculated based on these separate parts). The HHRA estimates risk based on calculated whole body concentrations. Differences in concentrations between the estimated whole body concentrations and specific body parts (e.g., head only, fillet only) are discussed in the uncertainty analysis. The sediment ingestion rate (400 mg/day) used in the HHRA incorporates incidental ingestion of residual sediments potentially adhered to unwashed aquatic plants (Harper, 2008). A discussion of potential impacts on the risk estimates related to use of different parts of biota during food preparation (for fish and aquatic plant) is provided in the uncertainty analysis.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
18	Specific Comment	8, Bullet 12	From a public health perspective, past exposures (e.g., in the town of Picher) are relevant to providing appropriate biomedical intervention and specific health advice to individuals. While this is not part of a risk assessment document, it will be relevant when preparing advice based on sampling results, especially if institutional controls are part of the remedy. In point of fact, people who have had past exposures in Picher may already be carrying a high lead burden even if their blood lead levels are now below 5 ug/dl, and some consideration should be made of those past exposures. Remedies are developed for future people who start with no pre-existing body burden and no past exposures, so protecting the health of current tribal members who already have an exposure history should be considered.	Comment noted.
19	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Introduction Memo to Tim Kent, QTO Environmental Program Director and RPM General Comments	1 and 2	This memo constitutes a review of the aforementioned document. Tim Kent has directed us to send this directly to you. In preparing these comments, the Tribe has attempted to focus on issues that could make a difference in the RI/FS and ultimately selection of the remedy in the Proposed Plan. The OU4-specific cleanup standards/goals have been developed without considering risk associated with the use of the other OUs. Remediation/removal in OU4 has proceeded relying on these values. Having this concern in 2015, made the Tribe realize that in order to save time and resources, we needed to develop a Reasonable Maximal Exposure Scenario (RME) for each OU as soon as possible.[1] Because the RMEs were not developed, a piecemeal approach is resulting in a requirement for perpetual institutional controls and 5-year reviews, as well as an inability to reuse the lands and resources for their intended uses.[2] Like the proposed plan and ROD, development of the OU5 RME should be a cooperative effort including EPA and the State, and needs to proceed without further delay. Ideally this will result in a cleanup where institutional controls and land use controls are not needed, and UU/UE can be achieved.[3]	The HHRA addresses potential exposures to media within OU5 only. The RME exposure scenarios and assumptions were identified with input from QTO and TCTCIT. The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
20	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - General Comment 1	2	The QTO Traditional Scenario was developed to represent the general or average Traditional QTO citizen who relies on both aquatic AND terrestrial resources—it is not a Reasonable Maximal Exposure (RME) for a given OU.[4] The RME should be a comprehensive site-wide exposure scenario, not an OU-specific exposure. As long as terrestrial and aquatic OUs are separated, the true OU-specific RME is one that describes individuals using either terrestrial OR aquatic OUs. The latter would be an RME for 100% time and 100% sustenance from each OU. For example, the RME for a person who is more reliant on aquatic resources would require a greater aquatic diet, water from surface water or mine discharge (whichever is higher) and more aquatic area exposure time. As presented by EPA, the OU5 user is recreational, which is by definition not comprehensive. Further, limiting OU5 use to recreational use is inconsistent with the Tribes' plans for land use, and is in effect an institutional control. It also prevents a multi-OU cumulative exposure assessment. The options are to either (1) develop an RME for 100% of time and diet in OU5 and another for 100% OU4, or (2) develop a combined OU4/OU5 RME that uses resources from both areas simultaneously (in effect assuming a relative source contribution from each OU). As currently devised, the OU4 user cannot use resources from OU5 because his/her risk allocation has already been filled, and vice versa.	The HHRA addresses potential exposures to aquatic resources within OU5 only. The RME exposure scenarios and assumptions for the Tribal Lifeway scenario – which includes surface water and sediment exposures from fishing, hunting, gathering, recreational activities, and sweat lodge use; potable use of surface water; consumption of aquatic biota and plants; and medicinal use of plants as salve – were identified with input from QTO and TCTCIT. Potential exposures to terrestrial resources (including soil contact, terrestrial small game and large game ingestion scenarios, and plant consumption) were addressed in the OU4 HHRA. The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.
21	Attachment No 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - General Comment 2	2	Based solely on the approach used to build the RAGS Table 4, the Tribe still foresees major problems associated with the HHRA for the future traditional resident. These problems are overarching and associated with balkanizing the site into OUs without reintegrating risk across the OUs to enable a comprehensive assessment of site risk as required by CERCLA. This concern has been raised by the Tribe previously and is clearly nothing new. The Tribe warned EPA on these issues as far back as 2004 and reiterated these concerns in no less than five memoranda. An early example first is General Comment 3, November 22, 2005	The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

<table>
<tr><th>Item</th><th>Section</th><th>Page</th><th>Comment</th><th>Response</th></tr>
<tr><td>22</td><td>Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - General Comment 3</td><td>3</td><td>The PRGs/RAOs do not consider the exposure that ecological or human receptors receive from the Surface water pathway as well as riparian resources. This is a major error and omission on the part of both the ecological and the Human Health Risk Assessments (this will be discussed in greater detail in comments on those reports). The residual exposure to humans from drinking surface water and using surface water in sweatlodge ceremonies alone exceed allowable risk. This risk is real and cannot be assumed away or managed via institutional controls such as signage or education— people are using these resources today. This means that that the allowable risk to Tribal members who use resources for traditional cultural practices will be exceeded even if the uplands are returned to background conditions.

The concept of an Operable Unit was developed to partition remedial actions into workable or manageable units—not to balkanize risk assessments. The NCP requires protection of human health and the environment for the reasonably foreseeable land use of the site—not of an OU. In summary, as long as the residual risk from OU1 is measurable, the allowable risk from other OUs must be reduced by an amount so that the cumulative site-wide risk does not exceed the threshold criteria. In this instance, the risk allocated for all other OUs has been usurped by OU1. Therefore, the PRG for all media (e.g. surface water, ground water, soils, floodplain sediments, and air) must be pre-release baseline (background). The following table is included as another early example (excerpted from Attachment No. 2). Pay particular attention to footnote No. 2 to the table.

Tribal Exposure Areas on Tribal lands
<table><tr><th>General Activity</th><th>Source Areas: Chat Piles/Bases/Flotation Tailings Ponds</th><th>Transition Zones</th><th>Wetlands/Streams [2]</th></tr><tr><td>Relative Potential for Tribal Residential Use</td><td>High</td><td>High</td><td>High</td></tr><tr><td>Relative Potential for Tribal Subsistence Fishing Use</td><td>NA</td><td>NA</td><td>High</td></tr><tr><td>Relative Potential for Tribal Gathering Use (Aquatic)</td><td>NA</td><td>NA</td><td>High</td></tr><tr><td>Relative Potential for Tribal Gathering Use (Terrestrial)</td><td>High</td><td>High</td><td>NA</td></tr><tr><td>Relative Potential for Tribal Hunting Use</td><td>High</td><td>High</td><td>High</td></tr><tr><td>Relative Potential for Tribal Recreational Use</td><td>High</td><td>High</td><td>High</td></tr><tr><td colspan="4">General Population Exposure on Tribal lands [1]</td></tr><tr><td>Relative Potential for General Public Sportfishing Use</td><td>NA</td><td>NA</td><td>Moderate-Low</td></tr><tr><td>Relative Potential for General Public Bathing Use</td><td>NA</td><td>NA</td><td>Moderate-Low</td></tr></table>NA = Not Applicable
[1] If members of the General Public (GP) reside on Tribal Lands, the residential recreational doses for the GP must also be determined.

[2] although this EA is not officially part of OU4, the dose from these areas must be considered in the Risk Assessment. If the Dose allocation from this EA equals or exceeds Risk Criteria defined by the NCP, then all other EAs must be cleaned-up to pre-release background conditions.</td><td>The approach for development of PRGs and target levels for various health endpoints (e.g., cancer risk, hazard index, blood lead level) have not yet been established.</td></tr>
</table>

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
23	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - General Comment 3	4	Conversion to g/kg-d. This seems to be a systemic problem. An example for fish from Table 3-1 is that the fish daily ingestion rate = 120 g/d; (mistakenly converted to 15 g/kg-d by EPA). This is simply a dilution of the 120 g/d estimate by a 70 kg person into an 80 kg person because EPA assumes that the same amount is eaten by both a 70 kg person and an 80 kg person. (120 g/d)/70 kg = 1.714 g/kg/d, not 1.5 g/kd-d. EPA's value of 1.5 g/kg-d comes from dividing the 120 g/d by 80 kg, which means that the larger person is eating less per body weight than the original 70 kg person. 2000 kcal (1526 g/d) is not enough to sustain an 80 kg person, as shown below (See Attachment). We do not dispute that the average American is now 80 kg. But this means that everyone is eating more. If EPA wants to assume that people are heavier today, then they also have to recognize that they eat more, i.e., every intake factor needs to be multiplied by 1.145. The goal for Tribes is to recapture its old lifestyle that leads to non-supersized people. The Traditional Scenario was developed for when people were a traditional size. If EPA wants to adjust to new super-sized people to assess risk for current conditions, they must scale all of the aforementioned exposure factors. However, the goal of the Tribe goal is for our future citizens to reach 70 kg once again. This means that the future traditional Tribal resident needs to be assessed assuming a traditional body weight of 70 kg, or alternately that the 80 kg person eats proportionally more. *We recommend that EPA also examines the total caloric intake for the whole diet and compare it to the caloric needs per kg of body weight, rather than simply diluting a 70-kg diet into an 80-kg body.*	A body weight of 70 kg was used for Tribal Lifeway adults in the HHRA, so no adjustment was needed for food intake rates.
24	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - General Comment 4	5	Use of two Canadian studies for reducing the soil ingestion rate. These two fecal tracer studies were conducted with the Nemiah Band, a traditional community; all food was provided to the participants by the investigators in the Davis et al. (2012) study, and participants were engaged in fisheries activities. A similar study of the same community was conducted by the same investigators (Irvine et al., 2014), with participants engaged in traditional activities; all food was provided to the participants by the investigators. As explained in Attachment No. 4: Soil Ingestion for Oklahoma," these two studies are not considered to be applicable to the Quapaw exposure scenario. QTO believes that decades of previous work with multiple lines of evidence is not invalidated by these two studies. The approved Quapaw scenario uses a soil/sediment ingestion of 400 mg/d; the attachment presents the rationale for reducing the soil ingestion rate for another Tribe that behaves differently to 330 mg/d if the other Tribe(s) so desire.	A sediment ingestion rate of 400 mg/day was used in the HHRA for Tribal Lifeway adults and children.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
25	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - General Comment 5	5	Geographic scope of OU5 needs to be revised. We see several problems: a. We cannot ascertain the geographic scope from the provided information. Does OU5 extend all the way to Grand Lake. Or is it solely within the OU4 boundary? b. It is not clear whether riparian and flood-plain soils are included and whether the nature and extent of contamination has been characterized downstream of the source area on the QTO reservation. c. Downstream Tribes who are not using the source area uplands should perhaps have a separate OU and subsequent RME based on that OU. That RME would include the floodplains where residences occur.	a. The geographic scope of OU5 is shown on Figure 1-1 of the HHRA. b. Riparian and floodplain soils were included in the HHRA for OU4. c. The RME for the Tribal Lifeway scenario in OU5 was based on input from both QTO and TCTCIT, with the more conservative input used where input differed. Floodplains are addressed in OU4.
26	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - General Comment 6	6	Frequency of sweat lodge use. The Quapaw scenario includes daily use of a sweatlodge. We note that asking one tribal member about a lower rate does not invalidate the value used in the officially approved scenario. However, if the downriver tribes wish to use a lower frequency, they may do so.	A sweat lodge exposure frequency of 365 days/year, exposure time of 1 hour/event, and exposure duration of 64 years is used for adults in the HHRA. These exposure assumptions are more conservative than input provided by Quapaw and TCTCIT. A sweat lodge exposure frequency of 365 days/year, exposure time of 1 hour/event, and exposure duration of 4 years (children ages 2 to 6) is used for children in the HHRA based on input from QTO since TCTCIT indicated that children do not use the sweat lodge.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
27	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comments	6, Table 3-1	• Does waterfowl data already exist (so it is not a data gap)? • Cell 8j: "Two plant types (duckweed and arrowhead root); duckweed = washed whole plant; arrowhead = washed tuber only, washed fine roots only, and washed leaves/stalk only." (OK, but duckweed is not listed in Table 4-1.) • Cell 11j: What grain size will be used in sieving? As EPA knows, more contaminants are adsorbed as the surface area increases with smaller grain sizes, and stream silt would have smaller grain sizes. Additionally, the sand- silt cutoff (63 um) is the point at which grittiness is detected and spit out. See the Soil Ingestion attachment for a longer discussion	As indicated in the Data Gap Summary Report (2017), site-specific waterfowl (duck) breast meat/tissue data were not identified during the compilation of existing data. However, based on information provided in the Bunker Hill Superfund Site HHRA (TerraGraphics, 2001) and additional literature (van der Merwe et al., 2011), waterfowl tissue are qualitatively assessed in the uncertainty analysis, so there is not a data gap. Duckweed and arrowhead plant are included in the HHRA dataset for aquatic plant consumption. The available dataset for sediment includes both sieved and unsieved samples; the sieved samples were sieved using various sieve sizes ranging from 2 mm to 63 µm.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
28	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comments	6, Table 4-1 Food	Footnote 3 – 10% of aquatic food is shellfish, which is reasonable, but what % of the total diet is aquatic?	The percentage of the total diet that is aquatic is not identified in the HHRA but is presented in Figure 9 of the *Quapaw Traditional Lifeways Scenario* (Harper, 2008). In this figure, the following food categories are shown as percentages of daily grams and are incorporated into the OU5 HHRA: • Aquatic and Fish 8% – 100% of the category is assumed to be OU5 fish and shellfish. • Small game 4% – 100% of the category is assumed to be OU5 semi-aquatic mammals (represented by raccoon samples). An additional 35% of the category is assumed to be OU5 amphibians and reptiles (represented by frog leg samples). • Roots and Bulbs 9% – 100% of the category is assumed to be OU5 aquatic plants (represented by duckweed and arrowhead samples). Based on the addition of these categories (8 + 4 + 9), approximately 21% of the diet is aquatic. An alternative (higher) Tribal Lifeway plant ingestion rate is presented in Appendix F4.
29	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comments	6, Table 4-1 Food	Footnote 4 – 20% of aquatic food is amphibian and reptile; 20% is plants. This leaves 50% for fish if small mammals are kept separate; again, what % of the total diet is comprised of aquatic-sourced foods, and what assumption are made about where the rest of the food comes from? It cannot come from OU4, because OU4 has already filled the entire risk allocation.	Approximately 21% of the total diet is aquatic. The rest of the food comes from terrestrial sources, consistent with Figure 9 of the *Quapaw Traditional Lifeways Scenario* (Harper, 2008). Terrestrial food items were addressed in the HHRA for OU4.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
30	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comments	6, Table 4-1 Food	It is not clear whether EPA intends to use a fish ingestion rate of 120 g/d plus shellfish (12 g/d), aquatic tubers (40 g/d), plus herps (24 g/d). or whether EPA intends to divide 120 g/d into different fractions.	As indicated in RAGS Tables 4.6 and 4.7 (RAGS tables are presented in Appendix B of the HHRA), the following ingestion rates are used for adults: fish = 90 g/day, shellfish = 30 g/day, frog = 24 g/day, raccoon = 69 g/day, and aquatic plants = 133 g/day.
31	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comments	6, Table 4-1 Food	Aquatic tubers = 40 g/d (no duckweed?)	As indicated in RAGS Table 4.7 of the HHRA, an aquatic plant ingestion rate of 133 g/day was used for adults; this ingestion rate is applied to the aquatic plant dataset consisting of duckweed and all arrowhead plant data.
32	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comments	6, Table 4-1 Food	Again, EPA should not convert a 70kg person diet into an 80kg person unless the values are raised to account for a larger person eating more.	A body weight of 70 kg was used for Tribal Lifeway adults in the HHRA, so no adjustment was needed for the intake rate.
33	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comments	6, Table 4-2 Sediment	The exposure frequency of 126 days per year is reasonable for recreational use, but the QTO has not agreed that OU4 is solely recreational or that it is off-limits to users of other OUs (due to unacceptable cumulative risk).	A sediment exposure frequency of 312 days/year is used for the Tribal Lifeway scenario in the HHRA, as indicated in RAGS Table 4.1.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
34	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comment	7, Table 4.3 SW Potable (surface water in creeks) and Table 4-4 SW (also in surface water creeks	It is not clear how these two tables are different. If the difference is expected to be related to exposure point concentration, then it would seem that a single set of exposure assumption should be used with several different exposure point concentrations (the creek, the mine drainage, the river, and groundwater).	The differences in the tables are based on exposure assumptions. Four RAGS tables present the exposure assumptions used in the HHRA for various Tribal Lifeway scenarios in surface water: • Table 4.2 – Water contacted during swimming and wading activities for 6 hrs/day (312 days/year for adults and 234 days/year for children) • Table 4.3 – Water used as a daily drinking water source (2.5 L/day for adults and 0.78 L/day for children) • Table 4.4 – Water as a drinking water source when using a sweat lodge (an additional 1 L/day for adults and children) • Table 4.5 – Water inhaled while in a sweat lodge Mine discharge is evaluated using the same exposure scenarios and assumptions as surface water in Appendix F3. Separate exposure point concentrations (EPCs) are used for each watershed.

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
35	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comment	7, Table 4.3 SW Potable (surface water in creeks) and Table 4-4 SW (also in surface water creeks	The drinking/swimming/sweatlodge RME should use maximum concentration of whatever resource is more contaminated. This will provide the upper bound of risk. Then, several mixes of the various sources would provide a more central tendency of risks (e.g., 50:50 GW and SW for 365 days/year, plus swimming during 126 days/year).	The exposure scenarios evaluated in the risk assessment are for chronic exposure durations (64 years for adults and 6 years for children for the Tribal Lifeway scenarios). Consistent with EPA guidance presented in *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (EPA, 2002), EPCs are based on 95% upper confidence limit (UCL) of the arithmetic mean concentrations (or mean concentrations for lead) rather than maximum detected concentrations. This approach is appropriate since chronic exposures would not occur to maximum detected concentrations. Groundwater was addressed in OU1 and is not addressed in the OU5 HHRA.
36	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comment	7, Table 4-5 SW sweat lodge	Infants (0-24 months) have no sweat lodge use (OK). See note above about frequency	Children below the age of 2 were not included as sweat lodge receptors in the HHRA.
37	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comment	7, Table 4-6 Arrowhead -medical salve (in addition to ingestion in Table 4-1	Includes dermal while digging, 12 d/yr x 64 yrs (adult) or 6 yrs (child). This is OK, but the same exposure is received when gathering for food use	The sediment ingestion rate (400 mg/day) used in the HHRA incorporates a variety of soil exposure pathways and activities such as wild foods harvesting and/or gathering, as indicated in Harper (2008).

Table 2b. Response to Comments Provided by AESE, Inc., on Behalf of Quapaw Nation on Document No. 2 and No. 3

Item	Section	Page	Comment	Response
38	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comment	7, Table 4-7 Discharge	Dermal exposure 1 hr/event (washing) x 10 events/yr. – adult and child. The exposure frequency should be the same as for the other water bodies, even if the drainage is intermittent.	The mine discharges occur intermittently, have a typically low flow rate, and are not easily accessible. Although the mine discharges are only intermittent and the discharges are not easily accessible, mine discharge was conservatively evaluated for the same exposure scenarios and assumptions as surface water in Appendix F3.
39	Attachment No. 1, December 13, 2017 on the Review of HHRA RAGS Part D Table 4 Review - Specific Comment	7, Table 4-7 Discharge	The RME should use the maximum concentration from whatever resource is more contaminated. Thus, this is a question of exposure point concentration, not exposure frequency	If at least eight sample results and four detections of a chemical are available in the dataset, EPCs are based on 95% UCL of the arithmetic mean concentrations (or mean concentrations for lead) rather than maximum detected concentrations. The use of 95% UCL of the arithmetic mean concentrations is consistent with EPA guidance presented in *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (EPA, 2002), This approach is appropriate since chronic exposures would not occur to maximum detected concentrations. Mine discharge was evaluated in Appendix F3.

Table 2c. Response to Comments Provided by ODEQ on Document No. 2

Item	Section	Page	Comment	Response
1	Cover Letter		As you will see, most of our comments are focused on requesting additional documentation and justification of the Reasonable Maximum Exposure (RME) input parameters. Without this documentation, DEQ may not be in a position to support the conclusions drawn from the Human Health Risk Assessment.	Comment noted.
2	General Concerns	1, Bullet 1	Per Oklahoma Department of Environmental Quality (DEQ) policy, any deviations from Risk Assessment Guidance for Superfund (RAGS) or default input parameters in the Human Health Risk Assessment (HHRA) process require approval from DEQ. Given that the authority for this HHRA is under EPA, DEQ requests to see any data or information available that will adequately justify some of the large deviations between defaults and the site specific inputs. Please see section 3.2, 3.3, and 3.4 for more specifics.	Comment noted.
3	General Concerns	1, Bullet 2	DEQ is concerned that several of the exposure scenarios presented in the Technical Memorandum reviewed and commented on in this document will result in remedial goals that are close to background concentrations.	Comment noted. However, the exposure scenarios addressed in the HHRA were identified through input from AESE/Quapaw Nation and TCTCIT.
4	2.0 General Objectives for the Tar Creek OU5 HHRA	1, Bullet 1	Is the focus of this HHRA to address current exposure scenarios or traditional exposure scenarios? For example, Harper, 2008 explicitly states “This report describes traditional uses. The purpose of this report is not to describe contemporary uses that are suppressed or distorted by lack of access, resource degradation, or knowledge of contamination.” However, the Tribal Lifeways Technical Memorandum (TM) states “Risks are estimated for current exposures to OU5 media as well as reasonably foreseeable future uses.” Currently, the HHRA uses both Traditional Quapaw Scenarios provided in the multiple Harper documents (Harper, 2007, 2008, and Harper et al. 2012) and current exposure scenarios provided by Tar Creek Trustee Council Indian Tribes (TCTCIT). DEQ requests that EPA provide clarification regarding this subject.	The focus is on Tribal Lifeway scenarios and General Public scenarios. Based on input from AESE/Quapaw Nation and TCTCIT, there are some tribal members and citizens who currently practice one or more aspects of the Tribal Lifeway scenario. Therefore, the exposure-scenario-specific and cumulative scenario risk estimates presented in the HHRA are applicable to the range of potential exposures for current and future site uses.

Table 2c. Response to Comments Provided by ODEQ on Document No. 2

Item	Section	Page	Comment	Response
5	2.0 General Objectives for the Tar Creek OU5 HHRA	2, Bullet 1	Are the goals of the exposure scenarios to have both traditional and current input parameters go into the Chronic Daily Intake models? For example, the sediment exposure scenario includes inputs derived from both Harper (2008) and TCTCIT.	The focus is on Tribal Lifeway scenarios and General Public scenarios. Based on input from AESE/Quapaw Nation and TCTCIT, there are some tribal members and citizens who currently practice one or more aspects of the Tribal Lifeway scenario. Therefore, the exposure-scenario-specific and cumulative scenario risk estimates presented in the HHRA are applicable to the range of potential exposures for current and future site uses. The final exposure assumptions for the Tribal Lifeway scenarios are presented in RAGS Tables 4.1 through 4.8.
6	2.0 General Objectives for the Tar Creek OU5 HHRA	2, Bullet 2	Can EPA provide documentation where mixed traditional/current lifeways have gone into the same risk scenarios at other Superfund Sites?	Based on input from AESE/Quapaw Nation and TCTCIT, there are some tribal members and citizens who currently practice one or more aspects of the Tribal Lifeway scenario. Therefore, the exposure-scenario-specific and cumulative scenario risk estimates presented in the HHRA are applicable to the range of potential exposures for current and future site uses. The Coeur d'Alene Basin HHRA (TerraGraphics, 2001) addresses both Traditional Tribal Subsistence Lifestyle and Current Subsistence Lifestyle scenarios.
7	2.0 General Objectives for the Tar Creek OU5 HHRA	2, Bullet 3	Are the exposure scenario assumptions provided more appropriate for restoration endpoints rather than remediation endpoints?	The RME exposure scenarios and assumptions are based on input received from AESE/Quapaw Nation and TCTCIT.

Table 2c. Response to Comments Provided by ODEQ on Document No. 2

Item	Section	Page	Comment	Response
8	2.0 General Objectives for the Tar Creek OU5 HHRA	2, Bullet 4	DEQ requests that EPA consider conducting surveys within Tribal Communities in order to have data supported input parameters for determining reasonable maximum exposure.	Based on input from AESE/Quapaw Nation and TCTCIT, some tribal members and citizens currently practice one or more aspects of the Tribal Lifeway scenario. Because there is a wide range in current use of resources within OU5, as well as many tribal members and citizens, the time needed to develop and administer a survey of current resource use would be lengthy and not practical. AESE/Quapaw Nation and TCTCIT have also indicated that there is limited value in surveys since current exposures may be suppressed due to tribal members' and citizens' knowledge of impacted media within the study area, and therefore do not reflect future use following site cleanup.
9	3.1 Surface Water Exposure Scenarios Potable Surface Water (Ingestion and Dermal) - Referencing Table 4.1 in CH2M (2018) and RAGS Part D Tables (November 2017)	2, Bullet 1	The Ingestion Rate (IR) for Tribal Adults is proposed to be 2.0 L/day. The IR for General Public Adults is 2.5 L/day. Are these differences intentional or accidental? DEQ proposes that the values be identical unless otherwise justifiable.	The HHRA uses a potable water ingestion rate of 2.5 L/day for both Tribal Lifeway adults and General Public adults, as indicated in RAGS Table 4.3. This final water ingestion rate (2.5 L/day) was updated to be higher than the value presented in Harper (2008) but is justifiable since Harper (2008) was based on EPA's default water ingestion rate available at the time it was written, but has since been updated (EPA, 2014).

Table 2c. Response to Comments Provided by ODEQ on Document No. 2

Item	Section	Page	Comment	Response
10	3.1 Surface Water Exposure Scenarios Potable Surface Water (Ingestion and Dermal) - Referencing Table 4.1 in CH2M (2018) and RAGS Part D Tables (November 2017)	2, Bullet 2	The Exposure Duration (ED) for Tribal Adults is 64 years, while the ED for General Public Adults is 20 years. Can EPA please explain the discrepancy?	The Tribal Lifeway scenario is assumed to occur within OU5 for a lifetime of 70 years (EPA's default value; EPA, 2014) – 64 years as an adult and 6 years as a child. However, the general public is assumed to live in the same place for 26 years (EPA's default residential exposure duration; EPA, 2014) – 20 years as an adult and 6 years as a child.
11	3.1 Surface Water Exposure Scenarios Potable Surface Water (Ingestion and Dermal) - Referencing Table 4.1 in CH2M (2018) and RAGS Part D Tables (November 2017)	2, Bullet 3	The Event Time (ET) for dermal exposure is different between Tribal Children (0.53 hr/event) and General Public Children (1 hr/event) with the longer time favoring the General Public. However, the ET for dermal exposure favors Tribal Adults (0.72 hr/event) versus General Public Adults (0.58 hr/event). This discrepancy does not make sense to DEQ, especially since the inputs appear to be coming from standard defaults listed (EPA, 2014) and (EPA, 2004) and are not times proposed by TCTCIT. Can EPA please elaborate and justify why these differences occur?	The final ET used in the HHRA was changed to 0.54 hour/event for dermal exposure for Tribal Lifeway children and General Public children, as shown in RAGS Table 4.3 of the HHRA.
12	3.1 Surface Water Exposure Scenarios Wading and Swimming Exposures (Ingestion and Dermal) - Referencing Table 4.2 in CH2M (2018) and RAGS Part D Tables (November 2017)	3, Bullet 1	DEQ has compared the exposure times and exposure frequencies of Tribal Adult and Tribal Child to default input parameters and find them to be well outside the norm. DEQ requests to review any data/information available to justify the proposed inputs. Are these exposure times based on traditional or contemporary exposure scenarios?	The swimming/wading exposure times for Tribal Lifeway are much higher than those for General Public adults and children. However, the Tribal Lifeway exposure times and exposure frequencies were based on input from TCTCIT and AESE/Quapaw Nation. Based on their input, an exposure time of 6 hrs/event is representative of both current and future exposure scenarios for some tribal members and citizens.

Table 2c. Response to Comments Provided by ODEQ on Document No. 2

Item	Section	Page	Comment	Response
13	3.1 Surface Water Exposure Scenarios Wading and Swimming Exposures (Ingestion and Dermal) - Referencing Table 4.2 in CH2M (2018) and RAGS Part D Tables (November 2017)	3, Bullet 2	There appears to be no ingestion rate for wading in the General Public scenario. This is not explicitly stated in the CH2M (2018) document but was part of the RAGS Part D Tables.	Agreed; wading by the general public is not expected to result in water ingestion exposures since only splashing would occur. Rather, incidental water ingestion exposures are associated with the swimming scenario and are included as indicated in RAGS Table 4.2.
14	3.13 Sweat Lodge Exposure Tribal Member	3, Bullet 1	DEQ has no disagreement with the inputs. However, we are confused about the actual exposure scenario regarding sweat lodges and metals. Our understanding of how sweat lodges work are that water is boiled or poured onto hot rocks, that in turn create steam or vapor. Heavy metal boiling points are all well over 1000° F. Almost certainly, sweat lodges do not reach 1000° F, therefore, heavy metals would precipitate out or stay in solution instead of volatilizing in the steam or vapor. A sweat lodge essentially works like a distillery except that instead of collecting the steam/vapor and condensing it back into water, the steam/vapor is allowed to escape. However, even if it is assumed that metals do stay in vapor, the exposure point would be the dermal adherence of vapor and not dermal adherence of the actual surface water. DEQ requests that EPA and TCTCIT reconsider the exposure scenario or attempt to measure the metal concentration in vapor to determine the actual exposure point concentration to skin.	The exposure assumptions for sweat lodge use are presented in RAGS Tables 4.4 and 4.5. Water exposures may occur by drinking, pouring on the skin, or inhaling water vapors. The approach used for quantifying inhalation exposures was based on that presented in the *Shoshone-Bannock Exposure Scenario for Use in Risk Assessment: Traditional Subsistence Lifeways* (S-B EWMP, 2016).
15	3.2 Sediment Exposures 3.2.1 Sediment Exposure (Ingestion and Dermal) - Referencing Table 4.2 in CH2M (2018) and RAGS Part D Tables (November 2017)	3, Bullet 1	Ingestion rate of Tribal Adults (400 mg/day) are nearly quadruple that of the General Public (100 mg/day). DEQ requests documentation or data that justify the deviations.	A sediment ingestion rate of 400 mg/day was used for Tribal Lifeway adults, consistent with the *Quapaw Traditional Lifeways Scenario* (Harper, 2008).

Table 2c. Response to Comments Provided by ODEQ on Document No. 2

Item	Section	Page	Comment	Response
16	3.2 Sediment Exposures 3.2.1 Sediment Exposure (Ingestion and Dermal) - Referencing Table 4.2 in CH2M (2018) and RAGS Part D Tables (November 2017)	4, Bullet 1	Ingestion rate of tribal children (400 mg/day) is nearly double that of general public children (200 mg/day). DEQ requests documentation or data that justify the deviations.	A sediment ingestion rate of 400 mg/day was used for Tribal Lifeway children, consistent with the *Quapaw Traditional Lifeways Scenario* (Harper, 2008).
17	3.2 Sediment Exposures 3.2.1 Sediment Exposure (Ingestion and Dermal) - Referencing Table 4.2 in CH2M (2018) and RAGS Part D Tables (November 2017)	4, Bullet 2	DEQ has compared the exposure times and exposure frequencies of Tribal Adult and Tribal Child to default input parameters and find them to be well outside the norm. DEQ requests documentation or data that justify the deviations.	Agreed that the exposure frequencies for Tribal Lifeway are much higher than those for General Public adults and children. However, the Tribal Lifeway exposure frequencies were based on input from TCTCIT and AESE/Quapaw Nation. The exposure frequency reflects a variety of exposure pathways and frequencies such as cooking, wild food harvesting and/or gathering, residual sediment on foods and clothing, and holding natural materials in the mouth while processing or using the materials.
18	3.2 Sediment Exposures 3.2.1 Sediment Exposure (Ingestion and Dermal) - Referencing Table 4.2 in CH2M (2018) and RAGS Part D Tables (November 2017)	4, Bullet 3	Soil to Skin Adherence Factor (SSAF) for tribal members (0.1 mg/cm2-day) is greater than the SSAF for the general public (0.07 mg/cm2-day). Are there physiological differences in dermal properties of tribal skin versus that of the general public? DEQ requests documentation or data that justify the deviations.	A SSAF of 0.1 was used for Tribal Lifeway adults and children for consistency with the *Quapaw Traditional Lifeways Scenario* (Harper, 2008). This value is recommended in the document to account for averaging among outdoor activities with moderate to high dermal adherence and indoor activities with a lower adherence rate. There are no known physiological differences in dermal properties of skin between tribal members and the general public, but the types of sediment contact conducted by the two groups may warrant the higher SSAF.

Table 2c. Response to Comments Provided by ODEQ on Document No. 2

Item	Section	Page	Comment	Response
19	3.3 Aquatic Biota Exposure Scenarios 3.3.2 Aquatic Food Ingestion Exposure Scenarios	4, Bullets 1 & 2	DEQ encourages EPA to review the following study conducted by University of Oklahoma and Harvard University http://grandlakemercurystudy.org/images/GrandLakeWatershedMercuryStudy_FinalReport_Sept2014.pdf and visit the website http://www.grandlakemercurystudy.org/Fish_Consumption.html The above referenced study has data for fish consumption rates, percent of native and non-native fish consumed, what type of fish are typically consumed, and where people frequently fish. The study is based on a sample size of n=150. DEQ requests this data be represented in the HHRA considering it is the only data available regarding these type of inputs.	The study was reviewed, and the fish ingestion rate published in *A longitudinal study of mercury exposure associated with consumption of freshwater fish from a reservoir in rural south central USA* (Dong et al., 2015) was used in the HHRA for General Public adults, as indicated in RAGS Table 4.6.
20	3.4 Mine Discharge	4, Bullet 1	DEQ questions whether the inputs (EF = 10 days/year, 1 hour event time) provided are representative of Reasonable Maximum Exposure. DEQ knows of four main areas were mine discharge comes to the surface: (1) Douthat Bridge (2) Mayer Ranch (3) SE Commerce, and (4) Holder Private Property. Two of these areas are currently being addressed with Passive Treatment Systems. While DEQ understands that it has no data to support its concern in regard to the Holder Private Property mine discharge, DEQ has never observed people in the mine discharge waters at Douthat Bridge.	There are three primary historical mine discharge areas: two in the Tar Creek watershed, and one in the Beaver Creek watershed. The two noted in the Tar Creek watershed are those associated with discharges in the Douthat area and the discharges in the Commerce area (Mayer Ranch and SE Commerce). The mine discharges sampled are representative of those that people could contact outside of creeks, rivers, and tributaries. Mine discharges in one area of the Tar Creek Watershed (in Commerce) are currently being treated by passive treatment systems at the point of discharge. Although the mine discharges within the remaining two areas occur intermittently, have a typically low flow rate, and are not easily accessible, mine discharge was conservatively evaluated for the same exposure scenarios and assumptions as surface water in Appendix F3.

Table 3a. Response to Comments Provided by ODEQ on January 8, 2018 on Document No. 3

Item	Section	Page	Comment	Response
1	Table 4.1 General Public		General Public Receptor (fish): No comment- values proposed seem reasonable	No action required.
2	Table 4.1 Tribal Members		Tribal Member Receptor (fish and friends): Are there any more recent data for ingestion of fish for tribal members? The value used for ingestion rate is described by the author as a traditional Quapaw/sustenance ingestion rate	As indicated in RAGS Table 4.6 of the HHRA, the following ingestion rate is used for Tribal Lifeway adults: fish = 90 g/day. The RME exposure assumptions are based on input received from AESE/Quapaw Nation and TCTCIT.
3	Total Daily Kcal Table - Tribal Members		Total Daily Kcal Table (Supporting Information): Please review the 1:1 ratio of Kcal to grams for fish (i.e 100 Kcal per 100g). On the USDA food composition database (https://ndb.nal.usda.gov/ndb/search/list) I was able to find at least five reports documenting nutrient composition for fish that are likely to be caught and eaten in the exposure points of the watersheds of Tar Creek. All values reported are above EPA's current assumption. • #15187, Bass, cooked, dry heat; 146 kcal per 100g • #15223, Catfish, cooked, dry heat; 105 Kcal per 100g • #15218, Sunfish, cooked, dry heat; 114 Kcal per 100g • #15195, Drum, cooked, dry heat; 153 Kcal per 100g • #15011, Catfish, breaded and fried; 229 Kcal per 100g	The values presented in the Total Daily Kilocalorie (Kcal) Table were a rough estimate of Kcal based on ingestion of resident fish and other aquatic resources (Harper, 2008). As indicated in RAGS Table 4.6 of the HHRA, the following ingestion rates are used in the HHRA for Tribal Lifeway adults: fish = 90 g/day (assuming that 75% of the Harper [2008] "Aquatic and Fish" category is fish).
4	Table 4.1 General Public		Fish Ingestion Rate Comparison: In table using EPA (2011) child and adult values for g/kg BW-day, the value for the adult has been miscalculated. It should be (0.88 g/kg BW-day} X (70 kg)= 61.6 g/day not 13.1 g/day.	As indicated in RAGS Table 4.6 of the HHRA, the following ingestion rate is used for General Public adults: fish = 67 g/day. The fish ingestion rate is based on a longitudinal study of mercury exposure associated with consumption of freshwater fish from a reservoir in rural south-central USA (Dong et al., 2015).

Table 3a. Response to Comments Provided by ODEQ on January 8, 2018 on Document No. 3

Item	Section	Page	Comment	Response
5	Table 4.2 General Public		General Public Receptor (Sediment): Why not use the SRC (2016) value for Exposure Frequency? The citation for the value seems more vetted than Professional Judgement. DEQ proposes using the SRC (2016) value unless there is clear justification for not using it.	The General Public exposure frequency of 28 days/year assumes 1 day/week for the months of April through October but no exposures for November through March, as indicated in RAGS Table 4.1 of the HHRA. Based on discussions with EPA Region 7, the SRC (2016) Streamlined HHRA was intentionally conservative. The exposure assumptions for General Public in OU5 are expected to be reasonable.
6	Table 4.2 Tribal Member		Tribal Member Receptor (Sediment): Why is the EPA (2004) Soil-to-Skin Adherence Factor of 0.2 mg/ cm 2 not being used for Tribal Member Receptor as it is being used for the General Public Receptor? The Harper (2008) manuscript suggests using the 0.1 adherence factor as a means to account for both indoor and outdoor activities which would have lower and higher adherence factors, respectively. It does not appear to endorse the adherence factor as a mechanism to describe the nature of skin. DEQ does not follow the logic for using the two different values, especially considering the increased Exposure Frequency value being proposed for the Tribal Member Receptor. DEQ proposes using the EPA (2004) adherence factor for both Tribal Member and General Public Receptors. However, if an alternate value is to be used, DEQ requests that the same adherence factor be used for both Tribal Member and General Public Receptors regardless of the value used in the final calculations.	A SSAF of 0.1 was used for Tribal Lifeway adults and children for consistency with the *Quapaw Traditional Lifeways Scenario* (Harper, 2008). This value is recommended in the document to account for averaging among outdoor activities with moderate to high dermal adherence and indoor activities with a lower adherence rate. There are no known physiological differences in dermal properties of skin between tribal members and the general public, but the types of sediment contact conducted by the two groups may warrant the higher SSAF.
7	Table 4.3 General Public		General Public Receptor (Surface Water- Swimming): Why not use the SRC (2016) value for Exposure Frequency? The citation for the value seems more vetted than Professional Judgement. DEQ proposes using the SRC (2016) value unless there is clear justification for not using it. Exposure time/duration for swimming and wading should be re-evaluated. DEQ feels like swimming and wading events are likely to last longer than one hour.	The General Public exposure frequency of 28 days/year assumes 1 hour/day, 1 day/week for the months of April through October but no exposures for November through March, as indicated in RAGS Table 4.2 of the HHRA. Based on discussions with EPA Region 7, the SRC (2016) Streamlined HHRA was intentionally conservative. The exposure assumptions for General Public in OU5 are expected to be reasonable.

Table 3a. Response to Comments Provided by ODEQ on January 8, 2018 on Document No. 3

Item	Section	Page	Comment	Response
8	Table 4.4 Tribal Member		Tribal Member Receptor (Surface Water - Swimming): Exposure time/duration for swimming and wading should be re-evaluated. DEQ feels like swimming and wading events are likely to last longer than one hour. Beyond what is explained in the footnotes, DEQ does not follow the logic behind differing Exposure Frequencies for swimming and wading (65 days/year vs 61 days/year). DEQ proposes that the values be equivalent, as they are in the general public receptor.	As indicated in RAGS Table 4.2 of the HHRA, the exposure time for swimming/ wading for Tribal Lifeway is 6 hours/day and the exposure frequency is 312 days/ year. The RME exposure assumptions are based on input received from TCTCIT.
9	Table 4.4 General Public		General Public Receptor {Surface Water - Potable): No comment -values proposed seem reasonable	No action required.
10	Table 4.3 Tribal Member		Tribal Member Receptor (Surface Water- Potable): No comment - values proposed seem reasonable Is it possible to adjust future tables 4.3 and 4.4 so that the same Exposure Scenario is being evaluated in each table? As it is now, there is some table dyslexia; which may cause some undue confusion.	No action required. Exposure factors are presented by media. Sediment is presented in RAGS Table 4.1 and surface water is presented in RAGS Table 4.2 of the HHRA.
11	Table 4.5 General Public		General Public Receptor (Mine Discharge): Exposure Frequency seems high to DEQ. Would support a lower value if decided to be used.	Although the mine discharges occur intermittently, have a typically low flow rate, and are not easily accessible, mine discharge was conservatively evaluated for the same exposure scenarios and assumptions as surface water in Appendix F3.
12	Table 4.7 Tribal Member		Tribal Member Receptor (Mine Discharge): Exposure Frequency seems high to DEQ. Would support a lower value if decided to be used. Is it possible to change this table to 4.5 so that the same Exposure Scenario is being evaluated in each table? As it is now, there is some table dyslexia; which may cause some undue confusion.	Although the mine discharges occur intermittently, have a typically low flow rate, and are not easily accessible, mine discharge was conservatively evaluated for the same exposure scenarios and assumptions as surface water in Appendix F3.

Table 3a. Response to Comments Provided by ODEQ on January 8, 2018 on Document No. 3

Item	Section	Page	Comment	Response
13	Table 4.5 Tribal Member		Tribal Member Receptor (Sweat Lodge): Ultimately, DEQ will support any value proposed by Tribal Stakeholders but it is DEQ's understanding that the current value for exposure frequency is too high. Sweat Lodge practice in Oklahoma appears to be a more spiritual/ceremonial experience rather than a daily experience.	The RME exposure assumptions are based on input received from AESE/Quapaw Nation and TCTCIT. A sweat lodge exposure frequency of 365 days/year, exposure time of 1 hour/event, and exposure duration of 64 years is used for adults in the HHRA. A sweat lodge exposure frequency of 365 days/year, exposure time of 1 hour/ event, and exposure duration of 4 years (children ages 2 to 6) is used for children in the HHRA based on input from QTO since TCTCIT indicated that children do not use the sweat lodge.
14	Table Unlisted		(Aquatic plants): No comment. DEQ will rely on Tribal Stakeholders for Exposure Frequency values.	No action required.

Table 3b. Response to Comments Provided by Bureau of Indian Affairs (BIA) on December 13, 2017 on Document No. 3

Item	Section	Page	Comment	Response
1			No comments	No action required.

Table 3c. Response to Comments Provided by Earl Hatley on January 17, 2018 on Document No. 3

Item	Section	Page	Comment	Response
1			Non-Food Exposure Assumptions It is assumed that tribal peoples are using surface water as potable water for drinking, cooking, etc. and non-tribal peoples are not, but will in the future. Question: Where does this assumption come from? Comment: Grand Lake is a primary drinking water source for many communities and rural water districts in the area, serving ALL customers (tribal and non-tribal). I am drinking this water through my tap via my rural water district, which obtains this water from the City of Vinita. Vinita obtains this water which they treat for drinking from Grand Lake. If the mine water and runoff from the Superfund Site area continue for years, unabated, then it could very well be that none of us will be able to use the area surface water as potable water the stated purposes in the Risk Assessment's assumptions.	Comment noted and considered in the HHRA framework.
2			Non-Food Exposure Assumptions Members of the public are assumed not to come in contact with sediments. Question: Given the assumption below this one that non-tribal peoples swim or wade in creeks or streams, how can they not be in contact with sediments? Comment: I like to fish. I also like to boat in the water. It is impossible not to be in contact with sediments doing these activities on the streams or along the shore of the Grand Lake. Another assumption is that non-Tribal do not hunt for mussels or shell fish. I know this is not true from personal observation. How do they harvest these with being in contact with sediments? Most people I know, including myself, love watercress and other water plants. It is assumed that non-tribal people aren't interested. My non-tribal friends are.	Comment noted and considered in the HHRA framework.

Table 3d. Response to Comments Provided by LEAD Agency on January 17, 2018 on Document No. 3

Item	Section	Page	Comment	Response
1			Comments received on LEAD website: I know that people eat more local caught fish than the EPA represents in their risk assessment, and would certainly eat more if they knew the fish were safe. I also know that most people are not swimming in the watershed because of the look of the water and fear of pollution. If we knew the water was safe, most people would be swimming in the waters and boating like they use to. SO, PLEASE TELL THIS TO EPA!! Please let them know how much fish you would like to eat if you knew they were safe and how much you would love to swim if you knew the water was safe. We all need to be involved. LEAD can't do it all. After all, YOU ARE LEAD! I am relatively new to this area. I moved here in August 2016. Tar Creek Superfund site has been in the news for many years, but seeing it and living in the direct path of the contamination is another matter. More-so, I have a child at home and I worry for her exposure. People here know about Tar Creek and the environmental pollution of heavy metals. People here use great caution and unfortunately, due to the contamination and danger of exposure, the creek is not used like it was prior to the realization of the contamination. If not for Tar Creek's contamination, I would fish in the creek at least 1 to 2 times a month, or 12-24 times per year. I would eat the fish I catch, which would total 2-4 fish per trip. This is 24 to 96 fish per year that my family would eat, including my child. My grave concern is that Tar Creek is a tributary to the Grand River and ultimately to the Grand Lake 'O The Cherokees. Grand Lake is a major residential lake and a thriving recreational lake. Fishing and water sports and boating are wide-spread in Grand Lake. Tar Creek is polluting Grand Lake in Oklahoma and people are generally unaware of this threat to their health, life and safety. Please clean up Tar Creek and warn people not to eat the fish, nor animals in the creeks' pathway/region, nor the native wild fruit and vegetables. Ottawa County enjoys a densely populated Native American demographic group, as there are 10 sovereign Tribes in the County. Many of these Native people have grown up for generations using Tar Creek and its environs for hunting, fishing, foraging, growing crops and raising animals. This is certainly the same for all demographic groups in this area, but there is a cultural tie to these lands from the Tribes and their people. We are a rural community. Many people hunt and fish and live off the land. Tar Creek's contamination is adversely affecting all of these people.	Comments noted and considered in the HHRA framework.

Table 3d. Response to Comments Provided by LEAD Agency on January 17, 2018 on Document No. 3

Item	Section	Page	Comment	Response
2			LEAD Agency conducted the Grand Lake Mercury Study which was a research project with the Harvard School of Public Health and OU Health Sciences Center in which 150 fishermen and women participated. The majority of the fish, etc. caught and eaten by these participants came from the upper Grand Lake and the Neosho River. From them we learned that they were fishing but fishing less than they wanted to, consuming fewer fish than they wanted due for the most part that they feared the quality and safety of the fish, turtles, frogs and crawdads caught locally. http://www.grandlakemercurystudy.org/Fish_Consumption.html People are fishing in Lytle Creek and when asked they will not say they eat them. But there are no warning signs up advising them NOT to eat them. There are no warning signs anywhere along any of the streams, rivers or upper Grand Lake with any advisory. The reason fewer people recreate in and around our impacted streams is because they know something is wrong with doing so. There is an often unspoken fear and concern also for the cattle and deer and other wildlife that consume water from these impacted waters and that are then consumed by the public. It is hard to separate the contaminated water from the land as the contaminated water flows over and through the land to the sediments and the concerned streams that flow. All those then flow to the rivers that fill the Grand Lake o' the Cherokees. The combined items on plates of food eaten by tribal and non-tribal residents need to be considered, not just the fish, but also freshwater mussels, frogs, turtles, wild onions found along the streams, the serving sizes and numbers of re-fills taken by each person. Also the dust on the plates, the dust breathed in, and the dust landing on the outdoor cooked foods adds to the loading of metals eaten. As we have learned from the Harvard School of Public Health research done at this site, we must remember there are impacts on our people from the multiple metals that are in these contaminated soils, sediment, dust and the foods we consume grown in the waters and in the soils. The metal contaminant exposures are linked to poor birth outcomes and impaired neurodevelopment. The multiple metals lead to more toxic effects on the brain than an individual metal. Living near this superfund site is bad for our health and we have probably been underestimating the impacts on our health and wellbeing for decades. Babies are born pre-polluted and impacted by their contaminated environments even before they are walking or talking, exposed by what the mother has consumed or breathed in from her environment.	Comments noted and considered in the HHRA framework.

Table 3d. Response to Comments Provided by LEAD Agency on January 17, 2018 on Document No. 3

Item	Section	Page	Comment	Response
			Our wish is for tribal and non-tribal persons to be able to use our perennially flowing creeks, streams, rivers within the Oklahoma portion of the Tri-State Mining District more fully as a resource for food and recreation, for drinking and for as the Cherokees, "to go to water" for our spiritual needs. As a member of the Cherokee Nation, one of the downstream tribes affected by the Tar Creek Superfund site, the contaminants continue finding new ways to effect both the environment and those who rely upon it. These residual metals end up in the Grand Lake o' the Cherokees, my only daily drinking water source, and certainly the source for the many fish eaten at the "fish frys" I and others attend throughout the year.	

Table 3e. Response to Comments Provided by Larry Tippit/Peoria Tribe of Indians of Oklahoma on January 18, 2018 on Document No. 3

Item	Section	Page	Comment	Response
1			Although the "Technical Assistance Service for Communities -- Tar Creek Superfund Site Fact Sheet - January 2018" and the attached tables questionnaire may be "specific /exact science", I believe they leave much to be desired in the way of actuality/real - life, and common sense. For example: Where the study tables are averaged out in daily average grams consumptions, most hunters / gatherers take fish and game and plant resources, " in season" when they are available, lawful, and /or most readily harvested. This means that a person or family may consume many pounds ("gorge" when plentiful) of a subsistence resource in season (maybe several weeks) and then stretch out their intake (by canning or other means of preserving) throughout the rest of the year, depending on when their stores are exhausted. Also, in my experience, many "children," young kids, with their exuberant activities, eat or consume more that their adult parents. Therefore, assuming that an adult may eat 120 grams of fish a day while a child (depending on the age, size, and activity) eats only 40 grams in the same period, is not a hard and fast or reliable fact. So it is not only possible, but also probable that the tables, as presented, do not and cannot present an accurate representation of the consumption of the resources, whether fish, mammal, or plant.	Exposure by hunter/gatherers is addressed by the Tribal Lifeway scenario. Additionally, an alternative (higher) percentage (of the adult ingestion rate) for children is presented in Appendix F4. Overall, the risk assessment process and assumptions account for short times when consumption of aquatic food items is higher and longer periods when consumption is lower.
2			Another point I wish to highlight is that in the way of aquatic exposure, many more people besides Tribal and Ottawa County residents are exposed to water, sediments, fish, game, and plant contaminants. There are many sportsmen and families that come from out of state to Ottawa County, particularly the Twin Bridges area and Miami City park, to fish and recreate. The Twin Bridges park is a regular site for out of state fishermen to come, put in their boats, and motor up both Spring and Neosho Rivers to fish for several different species of fish, including rough fish and paddle fish, as well as local game fish. This is especially evident during different spawning and fish "run" seasons, not counting the heated docks for fishing that are in use in spring and fall seasons and on not only the Spring and Neosho rivers, but Grand Lake also. Duck and goose hunter travel, in season, from other in-state areas and from out-of-state to hunt the Spring River / Neosho River / Grand Lake area, thereby being exposed to water, sediments, and possibly contaminated harvests of waterfowl. And this doesn't take into account the number of families that come to camp for days and weekends to swim, wade, and play in the parks and rivers and lake.	Sportsmen (including waterfowl hunters) and families who come from out-of-state to fish and recreate in specific watersheds are addressed by the General Public exposure scenarios for recreational exposures to surface water and sediment (28 days/year), which are presented by watershed in Tables 6-4 and 6-5. In addition, their consumption of fish (game and non-game) from specific watersheds is addressed by the Tribal Lifeway evaluation presented in Appendix F3. Consumption of waterfowl is discussed in Section 6.6.2.7, and as indicated, potential risks are not expected to be significant.

Table 3e. Response to Comments Provided by Larry Tippit/Peoria Tribe of Indians of Oklahoma on January 18, 2018 on Document No. 3

Item	Section	Page	Comment	Response
3			There is no way of having a realistic number of individuals that are impacted by the contamination from the mine wastes, sediments, and impacted waters in the Tri-State Mining District / Tar Creek Superfund site. Besides hunters, fishermen, and recreation, there are many farmers, ranchers, and other types of employments that come into contact with mining wastes and heavy metal impacted waters daily through their jobs. These too should somehow be figured in the picture or tables. Farmers and ranchers irrigate their crops and pastures from these water sources, thus a pathway. Gravel haulers obtain river gravel and sediments from river bottoms and floodplains for fill dirt that goes into someone's yard or house foundation pad, another pathway. State, Federal, and private fish and wildlife folks, game rangers and biologists are in constant contact with these waters and sediments. NRCS employees involved with conservation projects, stream bank stabilization, etc., deal regularly with aquatic resources, sediments and such. Tribal Environmental employees from all the different Tribes in Ottawa County are particularly exposed to waters and sediments and mine discharges. Peoria Aquatic Facility workers daily work with fish, aquatic organisms, wade in water and sediments, and monthly take surface and pore water and sediment samples, all from mining injured waters; and the list goes on.	Comment noted and considered in the HHRA framework.
4			Another issue dealing with cleanup has to do with the aesthetics of Ottawa County and the local cities. The documents presents the conclusion that the Tar Creek Superfund site will only be addressed for cleanup if the "cancer health risk " is between 1 in 10,000 and 1 in a million, and that on a site-by-site basis. The city of Miami is in a condition of deterioration. In spite of a growing Northeastern A & M Junior College, the city is in a state of decline. With no industry moving in, the City government has touted Miami as a "retirement" community. But who wants to move into a Superfund Contamination site, with so much visible contamination, much less the threat of contamination from air, soil, and water.	Comment noted and considered in the HHRA framework.
5			Not many employees of the Peoria Tribe have much to do with the taking of raccoons. But my research shows that there are four different "coon hunting clubs" in the area, each fielding between 30 to 60 members. Each club has regular seasonal hunts, besides contest or field trial invitational hunts (which may bring in hundreds of hunters, dogs, and spectators. There is no way of estimating the number of raccoons that are taken and / or consumed from these events.	Raccoon samples were collected and evaluated in the HHRA.

Appendix B
Risk Assessment Guidance for Superfund (RAGS) Part D Tables

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe	Medium	Exposure Medium	Exposure Point[1]	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection of Exposure Pathway
Current/ Future	Sediment (Rivers and Creeks)	Sediment (Rivers and Creeks)	Sediment (0 to 12 inches deep)[2]	Tribal Lifeway	Adult/Child	Incidental ingestion, dermal	Quant	Surface sediment may be contacted during hunting/fishing/gathering and recreational activities (swimming, wading)
				Aquatic Worker	Adult	Incidental ingestion, dermal		Surface sediment may be contacted during work
				General Public (Recreator)	Adult/Child	Incidental ingestion, dermal		Surface sediment may be contacted during recreational activities (swimming, wading, fishing, hunting)
	Surface Water (Rivers and Creeks) [3]	Surface Water (Rivers and Creeks)	Surface Water (Rivers & Creeks)	Tribal Lifeway	Adult/Child	Incidental ingestion, dermal		Surface water may be contacted during hunting/fishing/gathering and recreational use (swimming, wading)
				Aquatic Worker	Adult	Incidental ingestion, dermal		Surface water may be contacted during work
				General Public (Recreator)	Adult/Child	Incidental ingestion, dermal		Surface water may be contacted during recreational use (swimming, wading, fishing, hunting)
			Surface Water (Potable Use)	Tribal Lifeway	Adult/Child	Ingestion,dermal		Surface water may be used as a potable source (drinking and bathing)
				General Public	Adult/Child	Ingestion, dermal		Surface water may be used as a potable source (drinking and bathing)
			Surface Water (Sweat Lodge)	Tribal Lifeway	Adult/Child	Ingestion, dermal		Surface water may be contacted during sweat lodge use
			Water Vapor (Sweat Lodge)	Tribal Lifeway	Adult/Child	Inhalation		Water vapor in Sweat Lodge may be inhaled.
	Sediment/ Surface Water (Rivers and Creeks)	Aquatic Biota (Animal[4] and Plant[5] Tissue)	Fish Tissue	Tribal Lifeway	Adult/Child	Ingestion		Fish may be consumed for food[10]
				General Public (Fisher)	Adult/Child	Ingestion		Fish may be consumed for food[11]
			Shellfish Tissue	Tribal Lifeway	Adult/Child	Ingestion		Shellfish may be consumed for food[12]
			Aquatic Plant (as Food)	Tribal Lifeway	Adult/Child	Ingestion		Aquatic plants may be consumed for food[13]
			Aquatic Plant (as Salve)	Tribal Lifeway	Adult/Child	Dermal		Aquatic plants may be used for medicinal purposes[14]
			Amphibian/Aquatic Reptile[6] Tissue	Tribal Lifeway	Adult/Child	Ingestion		Frogs and turtles may be consumed for food[15]
			Semi-Aquatic Mammals[7] Tissue	Tribal Lifeway	Adult/Child	Ingestion		Semi-aquatic mammals may be consumed for food[16]

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe	Medium	Exposure Medium	Exposure Point[1]	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection of Exposure Pathway
			Waterfowl Tissue[8]	Tribal Lifeway	Adult/Child	Ingestion	Qual	Waterfowl (ducks and geese) may be consumed for food
				General Public (Hunter)	Adult/Child	Ingestion		
			Irrigated Crops (as Food)[9]	Crop Consumers	Adult/Child	Ingestion	N/A [9]	Irrigated crops may be consumed for food (expected to be unlikely)
			Livestock (Meat)[9]	Livestock (Meat) Consumers	Adult/Child	Ingestion	N/A [9]	Livestock (meat) may be consumed for food (expected to be unlikely)

Notes:

(1) Evaluation of site media is performed separately for each watershed. Chemicals of potential concern (COPCs) are selected by media based on aggregated data. Exposure point concentrations (EPCs) are calculated per watershed for sediment, surface water, and mine discharge. EPCs for biota COPCs are calculated based on aggregated data.

(2) Sediment (0 to 12 inches deep) from saturated zones of perennial rivers or creeks.

(3) Mine discharge evaluated using the same exposure assumptions as surface water in Appendix F.

(4) Terrestrial small game (birds, rabbits) and large game (deer, elk) were addressed under Operable Unit 4 (Source Material, Transition Zone Soil, Rural Residential Yards and Wells).

(5) Aquatic plants growing in the wet bank-to-bank section of perennial flowing rivers and creeks.

(6) Amphibians and aquatic reptiles living in the wet bank-to-bank section of perennial flowing rivers and creeks.

(7) Semi-aquatic mammals (raccoon, beaver, mink, muskrat, otter) living in the wet bank-to-bank section of perennial flowing rivers and creeks.

(8) Potential risk associated with waterfowl consumption is evaluated qualitatively.

(9) The use of surface water for the irrigation of crops or as drinking water for livestock is unknown and expected to be unlikely due to the extent of annual rainfall in the area.

(10) Potential risk associated with fish consumption by the Tribal lifeway receptors is evaluated using two datasets: (1) whole body eviscerated and (2) head with bones.

(11) Potential risk associated with fish consumption by the general public is evaluated using the fish filet dataset.

(12) Potential risk associated with shellfish consumption is evaluated using the Asian clam and mussel samples.

(13) Potential risk associated with aquatic plant consumption is evaluated using the arrowhead and duckweed samples.

(14) Potential risk associated with medical use of aquatic plants is evaluated using the arrowhead samples.

(15) Potential risk associated with amphibian/aquatic reptile consumption is evaluated using the frog leg samples.

(16) Potential risk associated with semi-aquatic mammal consumption is evaluated using the raccoon samples.

Types of Analysis:

N/A = not applicable
Quant = quantitative analysis
Qual = qualitative analysis

TABLE 2.1a
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks) - Tribal Lifeway and Aquatic Workers

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value [Sieved] (1)	Background Value [Unsieved] (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (2)
Sediment (0-12 inch deep) (Sieved and Unsieved) Sitewide	7429-90-5	Aluminum	3.20E+00		2.80E+04		mg/kg	7185190	374 / 374	-	NA	1.86E+04	1.25E+04	NA	NA	NA	YES	--
	7440-36-0	Antimony	2.00E-01	J	7.49E+02	J	mg/kg	CERC-401	81 / 304	0.5-32.3	NA	5.53E-01	1.00E+00	NA	NA	NA	YES	--
	7440-38-2	Arsenic	6.90E-01	LJ	3.26E+02	J	mg/kg	TCSW080	342 / 360	0.6-10	NA	2.42E+01	1.44E+01	NA	NA	NA	YES	--
	7440-39-3	Barium	6.90E+00		5.50E+02		mg/kg	370215094463600	301 / 339	22.2-54.5	NA	2.73E+02	1.21E+02	NA	NA	NA	YES	--
	7440-41-7	Beryllium	3.10E-02	LJ	4.10E+00		mg/kg	LS 01 - Kansas	251 / 349	0.446-2.69	NA	2.50E+00	2.47E+00	NA	NA	NA	YES	--
	7440-42-8	Boron	2.80E+00		6.40E+01		mg/kg	370432094494000	10 / 19	2.5-2.5	NA	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	3.00E-01		4.17E+03		mg/kg	TCSW121	413 / 458	0.07-2.57	NA	8.18E-01	7.00E-01	NA	NA	NA	YES	--
	7440-70-2	Calcium	6.70E+02		9.23E+04		mg/kg	TCSW141	294 / 295	569-569	NA	2.61E+03	NA	NA	NA	NA	NO	NUT
	7440-47-3	Chromium	2.60E-01	LJ	1.60E+02		mg/kg	370215094463600	364 / 374	1.4-60	NA	4.15E+01	6.67E+01	NA	NA	NA	YES	--
	7440-48-4	Cobalt	1.00E+00	J	3.90E+02		mg/kg	TCSW124	277 / 349	5-60	NA	3.08E+01	3.30E+01	NA	NA	NA	YES	--
	7440-50-8	Copper	7.00E-01	J	7.60E+02	J	mg/kg	RVR0003-0004SD	370 / 374	3-60	NA	1.74E+01	1.32E+01	NA	NA	NA	YES	--
	7439-89-6	Iron	1.80E+00		4.97E+05		mg/kg	TCSW080	374 / 374	-	NA	7.70E+04	1.01E+05	NA	NA	NA	YES	--
	7439-92-1	Lead	6.00E+00		4.04E+04	J	mg/kg	RVR0003-0004SD	461 / 463	10-10	NA	4.42E+01	5.84E+01	NA	NA	NA	YES	--
	7439-93-2	Lithium	2.10E+01		8.20E+01		mg/kg	370215094463600	36 / 36	-	NA	NA	NA	NA	NA	NA	YES	--
	7439-95-4	Magnesium	1.10E+01	LJ	1.86E+04		mg/kg	TCSW100	234 / 295	589-2690	NA	2.22E+03	NA	NA	NA	NA	NO	NUT
	7439-96-5	Manganese	9.00E+00		1.13E+04		mg/kg	TCSW124	374 / 374	-	NA	1.80E+03	1.17E+03	NA	NA	NA	YES	--
	7439-97-6	Mercury	4.97E-03		6.49E+00	J	mg/kg	LC-307	157 / 302	0.067-0.9	NA	5.00E-02	3.16E-02	NA	NA	NA	YES	--
	7439-98-7	Molybdenum	1.00E+00	J	1.10E+02		mg/kg	TCSW080	66 / 136	1-50	NA	2.00E+00	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	1.10E+00	LJ	1.05E+03		mg/kg	TCSW124	328 / 374	4.96-20.5	NA	3.85E+01	5.26E+01	NA	NA	NA	YES	--
	7723-14-0	Phosphorus	4.00E+02		1.70E+03		mg/kg	370144094440500	36 / 36	-	NA	NA	NA	NA	NA	NA	YES	--
	7440-09-7	Potassium	5.59E+01	LJ	4.00E+03		mg/kg	BRSH1_KDHE	176 / 271	446-2690	NA	2.80E+03	NA	NA	NA	NA	NO	NUT
	7782-49-2	Selenium	5.00E-01	J	5.00E+01	J	mg/kg	TCSW065	131 / 349	0.6-50	NA	1.70E+00	1.02E+01	NA	NA	NA	YES	--
	7631-86-9	Silica (as SIO2)	9.60E+01		7.82E+03	J	mg/kg	TCSW108	96 / 96	-	NA	NA	NA	NA	NA	NA	YES	--
	7440-22-4	Silver	6.00E-02	J	9.77E+00		mg/kg	CERC-57	95 / 348	0.1-5.38	NA	9.00E-02	4.00E-01	NA	NA	NA	YES	--
	7440-23-5	Sodium	1.20E+01		2.15E+03		mg/kg	TCSW124	168 / 295	62.1-2690	NA	1.40E+02	NA	NA	NA	NA	NO	NUT
	7440-24-6	Strontium	4.50E+01		1.40E+02		mg/kg	370617094444200	36 / 36	-	NA	NA	NA	NA	NA	NA	YES	--
	7440-28-0	Thallium	7.00E-02	J	5.30E+00		mg/kg	TCSW100	74 / 340	0.08-100	NA	3.20E-01	9.00E-01	NA	NA	NA	YES	--
	7440-32-6	Titanium	2.80E-01		5.30E-01		mg/kg	370444094442600, 370451094463700, 370505094453500	36 / 36	-	NA	NA	NA	NA	NA	NA	NO	NTX
	7440-62-2	Vanadium	5.20E+00	J	1.30E+02		mg/kg	370617094444200	233 / 262	5.6-26.9	NA	NA	6.12E+01	NA	NA	NA	YES	--
	7440-66-6	Zinc	2.06E+01		1.26E+05		mg/kg	NR-105	385 / 385	-	NA	2.11E+02	5.34E+02	NA	NA	NA	YES	--

Notes:
(1) Background values are the 95/95 Upper Tolerance Limit (UTL) for sediment from *Tar Creek Superfund Site Operable Unit 5 Ottawa County, Oklahoma Remedial Investigation Report* (April, 2019).
(2) Rationale Codes:
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
LJ = result is estimated (low)
mg/kg = milligram per kilogram
NA = not available

TABLE 2.1b
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks) - General Public

Exposure Point	CAS Number	Chemical	Minimum Concentration	Min Qual	Maximum Concentration	Max Qual	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value [Sieved] (2)	Background Value [Unsieved] (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (4)
Sediment (0-12 inch deep) (Sieved and Unsieved) Sitewide	7429-90-5	Aluminum	3.20E+00		2.80E+04		mg/kg	7185190	374 / 374	-	2.80E+04	1.86E+04	1.25E+04	7.70E+03	NA	NA	YES	ASL
	7440-36-0	Antimony	2.00E-01	J	7.49E+02	J	mg/kg	CERC-401	81 / 304	0.5-32.3	7.49E+02	5.53E-01	1.00E+00	3.10E+00	NA	NA	YES	ASL
	7440-38-2	Arsenic	6.90E-01	LJ	3.26E+02	J	mg/kg	TCSW080	342 / 360	0.6-10	3.26E+02	2.42E+01	1.44E+01	6.80E-01	NA	NA	YES	ASL
	7440-39-3	Barium	6.90E+00		5.50E+02		mg/kg	370215094463600	301 / 339	22.2-54.5	5.50E+02	2.73E+02	1.21E+02	1.50E+03	NA	NA	NO	BSL
	7440-41-7	Beryllium	3.10E-02	LJ	4.10E+00		mg/kg	LS 01 - Kansas	251 / 349	0.446-2.69	4.10E+00	2.50E+00	2.47E+00	1.60E+01	NA	NA	NO	BSL
	7440-42-8	Boron	2.80E+00		6.40E+01		mg/kg	370432094494000	10 / 19	2.5-2.5	6.40E+01	NA	NA	1.60E+03	NA	NA	NO	BSL
	7440-43-9	Cadmium	3.00E-01		4.17E+03		mg/kg	TCSW121	413 / 458	0.07-2.57	4.17E+03	8.18E-01	7.00E-01	7.10E+00	NA	NA	YES	ASL
	7440-70-2	Calcium	6.70E+02		9.23E+04		mg/kg	TCSW141	294 / 295	569-569	9.23E+04	2.61E+03	NA	NA	NA	NA	NO	NUT
	7440-47-3	Chromium	2.60E-01	LJ	1.60E+02		mg/kg	370215094463600	364 / 374	1.4-60	1.60E+02	4.15E+01	6.67E+01	3.00E-01	NA	NA	YES	ASL
	7440-48-4	Cobalt	1.00E+00	J	3.90E+02		mg/kg	TCSW124	277 / 349	5-60	3.90E+02	3.08E+01	3.30E+01	2.30E+00	NA	NA	YES	ASL
	7440-50-8	Copper	7.00E-01	J	7.60E+02	J	mg/kg	RVR0003-0004SD	370 / 374	3-60	7.60E+02	1.74E+01	1.32E+01	3.10E+02	NA	NA	YES	ASL
	7439-89-6	Iron	1.80E+00		4.97E+05		mg/kg	TCSW080	374 / 374	-	4.97E+05	7.70E+04	1.01E+05	5.50E+03	NA	NA	YES	ASL
	7439-92-1	Lead	6.00E+00		4.04E+04	J	mg/kg	RVR0003-0004SD	461 / 463	10-10	4.04E+04	4.42E+01	5.84E+01	4.00E+02	NA	NA	YES	ASL
	7439-93-2	Lithium	2.10E+01		8.20E+01		mg/kg	370215094463600	36 / 36	-	8.20E+01	NA	NA	1.60E+01	NA	NA	YES	ASL
	7439-95-4	Magnesium	1.10E+01	LJ	1.86E+04		mg/kg	TCSW100	234 / 295	589-2690	1.86E+04	2.22E+03	NA	NA	NA	NA	NO	NUT
	7439-96-5	Manganese	9.00E+00		1.13E+04		mg/kg	TCSW124	374 / 374	-	1.13E+04	1.80E+03	1.17E+03	1.80E+02	NA	NA	YES	ASL
	7439-97-6	Mercury	4.97E-03		6.49E+00	J	mg/kg	LC-307	157 / 302	0.067-0.9	6.49E+00	5.00E-02	3.16E-02	2.30E+00	NA	NA	YES	ASL
	7439-98-7	Molybdenum	1.00E+00	J	1.10E+02		mg/kg	TCSW080	66 / 136	1-50	1.10E+02	2.00E+00	NA	3.90E+01	NA	NA	YES	ASL
	7440-02-0	Nickel	1.10E+00	LJ	1.05E+03		mg/kg	TCSW124	328 / 374	4.96-20.5	1.05E+03	3.85E+01	5.26E+01	1.50E+02	NA	NA	YES	ASL
	7723-14-0	Phosphorus	4.00E+02		1.70E+03		mg/kg	370144094440500	36 / 36	-	1.70E+03	NA	NA	1.60E-01	NA	NA	YES	ASL
	7440-09-7	Potassium	5.59E+01	LJ	4.00E+03		mg/kg	BRSH1_KDHE	176 / 271	446-2690	4.00E+03	2.80E+03	NA	NA	NA	NA	NO	NUT
	7782-49-2	Selenium	5.00E-01	J	5.00E+01	J	mg/kg	TCSW065	131 / 349	0.6-50	5.00E+01	1.70E+00	1.02E+01	3.90E+01	NA	NA	YES	ASL
	7631-86-9	Silica (as SIO2)	9.60E+01		7.82E+03	J	mg/kg	TCSW108	96 / 96	-	7.82E+03	NA	NA	4.30E+05	NA	NA	NO	BSL
	7440-22-4	Silver	6.00E-02	J	9.77E+00		mg/kg	CERC-57	95 / 348	0.1-5.38	9.77E+00	9.00E-02	4.00E-01	3.90E+01	NA	NA	NO	BSL
	7440-23-5	Sodium	1.20E+01		2.15E+03		mg/kg	TCSW124	168 / 295	62.1-2690	2.15E+03	1.40E+02	NA	NA	NA	NA	NO	NUT
	7440-24-6	Strontium	4.50E+01		1.40E+02		mg/kg	370617094444200	36 / 36	-	1.40E+02	NA	NA	4.70E+03	NA	NA	NO	BSL
	7440-28-0	Thallium	7.00E-02	J	5.30E+00		mg/kg	TCSW100	74 / 340	0.08-100	5.30E+00	3.20E-01	9.00E-01	7.80E-02	NA	NA	YES	ASL
	7440-32-6	Titanium	2.80E-01		5.30E-01		mg/kg	370444094442600, 370451094463700, 370505094453500	36 / 36	-	5.30E-01	NA	NA	NA	NA	NA	NO	NTX
	7440-62-2	Vanadium	5.20E+00	J	1.30E+02		mg/kg	370617094444200	233 / 262	5.6-26.9	1.30E+02	NA	6.12E+01	3.90E+01	NA	NA	YES	ASL
	7440-66-6	Zinc	2.06E+01		1.26E+05		mg/kg	NR-105	385 / 385	-	1.26E+05	2.11E+02	5.34E+02	2.30E+03	NA	NA	YES	ASL

Notes:
(1) Maximum concentration is used for screening.
(2) Background values are the 95/95 Upper Tolerance Limit (UTL) for sediment from *Tar Creek Superfund Site Operable Unit 5 Ottawa County, Oklahoma Remedial Investigation Report* (April, 2019).
(3) EPA RSL for residential soil (November 2019) based on a target cancer risk of 1×10^{-6} and a non-cancer hazard quotient (HQ) of 0.1.
The RSL for Chromium(VI) was used for Chromium, total.
The RSL for Mercuric Chloride was used for Mercury.
(4) Rationale Codes:
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Below Screening Level (BSL)
Essential Nutrient (NUT)

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
c = carcinogenic
COPC = Chemical of Potential Concern
G = Lead screening level based on blood lead modeling, as cited in Section 5.2 of RSL User's Guide
J = compound was detected below the reporting limit in the sample
LJ = result is estimated (low)
mg/kg = milligram per kilogram
n = non-carcinogenic
NA = not available
R = Relative bioavailability absorption was applied
RSL = Regional Screening Level

TABLE 2.2a
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks) - Tribal Lifeway and Aquatic Workers

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (2)
Surface Water (Rivers and Creeks) Sitewide	7429-90-5	Aluminum	7.53E-03		3.96E+01		mg/L	7185000	1266 / 1482	0.03-0.923	NA	1.65E+00	NA	NA	NA	YES	--
	7440-36-0	Antimony	7.00E-04	J	3.30E-03	LJ	mg/L	RVR0001-0016SW, RVR0001-0019SW	7 / 374	0.0002-0.06	NA	3.00E-04	NA	NA	NA	YES	--
	7440-38-2	Arsenic	5.00E-04	J	2.33E-01		mg/L	M-SA	395 / 734	0.0002-0.03	NA	5.00E-03	NA	NA	NA	YES	--
	7440-39-3	Barium	8.00E-03	J	4.00E-01		mg/L	7185000	345 / 425	0.01-0.2	NA	9.69E-02	NA	NA	NA	YES	--
	7440-41-7	Beryllium	2.00E-04	J	2.80E-04	LJ	mg/L	RVR0001-0011SW	2 / 374	0.0001-0.02	NA	5.00E-03	NA	NA	NA	YES	--
	7440-43-9	Cadmium	1.40E-05		3.61E-01		mg/L	TCSW110	1271 / 1590	0.000002-0.01	NA	6.40E-03	NA	NA	NA	YES	--
	7440-70-2	Calcium	2.00E-01	J	1.07E+03		mg/L	UT-P	1474 / 1477	0.3-1	NA	4.39E+01	NA	NA	NA	NO	NUT
	7440-47-3	Chromium	5.00E-04	J	6.12E-02		mg/L	TC-US69	356 / 817	0.001-0.1	NA	2.00E-02	NA	NA	NA	YES	--
	7440-48-4	Cobalt	3.52E-04		1.24E-01		mg/L	UT-P	848 / 1175	0.0006-0.1	NA	1.40E-03	NA	NA	NA	YES	--
	7440-50-8	Copper	2.22E-04		2.20E-01		mg/L	TCSW110	1112 / 1498	0.0007-0.1	NA	2.00E-02	NA	NA	NA	YES	--
	7439-89-6	Iron	1.00E-02	J	2.56E+02		mg/L	M-SA	1547 / 1557	0.02-0.1	NA	3.13E+00	NA	NA	NA	YES	--
	7439-92-1	Lead	2.00E-04	J	1.31E+00		mg/L	TCSW110	1051 / 1339	0.0002-5	NA	5.00E-03	NA	NA	NA	YES	--
	7439-95-4	Magnesium	1.29E+00		1.73E+03		mg/L	MR-UTD	1435 / 1477	1-5	NA	9.61E+00	NA	NA	NA	NO	NUT
	7439-96-5	Manganese	3.34E-03		1.21E+01		mg/L	MR-UTU	1514 / 1527	0.005-0.03	NA	8.93E-01	NA	NA	NA	YES	--
	7439-97-6	Mercury	2.50E-05	LJ	6.00E-04	J	mg/L	TCSW110	6 / 296	0.0002-0.001	NA	3.00E-04	NA	NA	NA	YES	--
	7439-98-7	Molybdenum	6.00E-04	J	1.00E-02	J	mg/L	TCSW040, TCSW061, TCSW063, TCSW065,TCSW066, TCSW067	9 / 214	0.0004-0.1	NA	2.00E-02	NA	NA	NA	YES	--
	7440-02-0	Nickel	1.59E-03		1.10E+00		mg/L	M-SA	1193 / 1454	0.01-0.1	NA	2.00E-02	NA	NA	NA	YES	--
	7440-09-7	Potassium	5.00E-01	J	4.63E+01		mg/L	MR-UTD	965 / 1009	1-5	NA	9.76E+00	NA	NA	NA	NO	NUT
	7782-49-2	Selenium	4.00E-04	J	3.00E-03	J	mg/L	TCSW111	21 / 386	0.0004-0.035	NA	1.00E-02	NA	NA	NA	YES	--
	7631-86-9	Silica (as SIO2)	2.00E-01	J	4.41E+01		mg/L	TCSW110	116 / 118	0.5-0.5	NA	NA	NA	NA	NA	YES	--
	7440-22-4	Silver	1.90E-04	J	6.50E-04	LJ	mg/L	RVR0001-0011SW	7 / 374	0.0003-0.01	NA	1.00E-02	NA	NA	NA	YES	--
	7440-23-5	Sodium	1.94E+00		8.19E+02		mg/L	TCSW124	1420 / 1450	1-5	NA	1.20E+01	NA	NA	NA	NO	NUT
	7440-28-0	Thallium	1.00E-04	J	1.60E-03	J	mg/L	TCSW075	45 / 296	0.0001-0.025	NA	5.00E-03	NA	NA	NA	YES	--
	7440-62-2	Vanadium	4.00E-04	J	1.00E-02	J	mg/L	TCSW064, TCSW110, TCSW128	34 / 296	0.02-0.05	NA	2.00E-02	NA	NA	NA	YES	--
	7440-66-6	Zinc	2.87E-03		6.34E+01		mg/L	TCSW110	2115 / 2177	0.0005-0.0612	NA	3.10E-02	NA	NA	NA	YES	--

Notes:
(1) Background values are the 95/95 Upper Tolerance Limit (UTL) for surface water from *Tar Creek Superfund Site Operable Unit 5 Ottawa County, Oklahoma Remedial Investigation Report* (April, 2019); values are for "total" metals.
(2) Rationale Codes:
Deletion Reason: Essential Nutrient (NUT)

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
LJ = result is estimated (low)
mg/L = milligram per liter
NA = not available

TABLE 2.2b
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks) - General Public

Exposure Point	CAS Number	Chemical	Minimum Concentration Qualifier	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (4)
Surface Water (Rivers and Creeks) Sitewide	7429-90-5	Aluminum	7.53E-03	3.96E+01	mg/L	7185000	1266 / 1482	0.03-0.923	3.96E+01	1.65E+00	2.00E+00 n	NA	NA	YES	ASL
	7440-36-0	Antimony	7.00E-04 J	3.30E-03 LJ	mg/L	RVR0001-0016SW, RVR0001-0019SW	7 / 374	0.0002-0.06	3.30E-03	3.00E-04	7.80E-04 n	NA	NA	YES	ASL
	7440-38-2	Arsenic	5.00E-04 J	2.33E-01	mg/L	M-SA	395 / 734	0.0002-0.03	2.33E-01	5.00E-03	5.20E-05 c	NA	NA	YES	ASL
	7440-39-3	Barium	8.00E-03 J	4.00E-01	mg/L	7185000	345 / 425	0.01-0.2	4.00E-01	9.69E-02	3.80E-01 n	NA	NA	YES	ASL
	7440-41-7	Beryllium	2.00E-04 J	2.80E-04 LJ	mg/L	RVR0001-0011SW	2 / 374	0.0001-0.02	2.80E-04	5.00E-03	2.50E-03 n	NA	NA	NO	BSL
	7440-43-9	Cadmium	1.40E-05	3.61E-01	mg/L	TCSW110	1271 / 1590	0.000002-0.01	3.61E-01	6.40E-03	9.20E-04 n	NA	NA	YES	ASL
	7440-70-2	Calcium	2.00E-01 J	1.07E+03	mg/L	UT-P	1474 / 1477	0.3-1	1.07E+03	4.39E+01	NA	NA	NA	NO	NUT
	7440-47-3	Chromium	5.00E-04 J	6.12E-02	mg/L	TC-US69	356 / 817	0.001-0.1	6.12E-02	2.00E-02	3.50E-05 c	NA	NA	YES	ASL
	7440-48-4	Cobalt	3.52E-04	1.24E-01	mg/L	UT-P	848 / 1175	0.0006-0.1	1.24E-01	1.40E-03	6.00E-04 n	NA	NA	YES	ASL
	7440-50-8	Copper	2.22E-04	2.20E-01	mg/L	TCSW110	1112 / 1498	0.0007-0.1	2.20E-01	2.00E-02	8.00E-02 n	NA	NA	YES	ASL
	7439-89-6	Iron	1.00E-02 J	2.56E+02	mg/L	M-SA	1547 / 1557	0.02-0.1	2.56E+02	3.13E+00	1.40E+00 n	NA	NA	YES	ASL
	7439-92-1	Lead	2.00E-04 J	1.31E+00	mg/L	TCSW110	1051 / 1339	0.0002-5	1.31E+00	5.00E-03	1.50E-02 G	NA	NA	YES	ASL
	7439-95-4	Magnesium	1.29E+00	1.73E+03	mg/L	MR-UTD	1435 / 1477	1-5	1.73E+03	9.61E+00	NA	NA	NA	NO	NUT
	7439-96-5	Manganese	3.34E-03	1.21E+01	mg/L	MR-UTU	1514 / 1527	0.005-0.03	1.21E+01	8.93E-01	4.30E-02 n	NA	NA	YES	ASL
	7439-97-6	Mercury	2.50E-05 LJ	6.00E-04 J	mg/L	TCSW110	6 / 296	0.0002-0.001	6.00E-04	3.00E-04	5.70E-04 n	NA	NA	YES	ASL
	7439-98-7	Molybdenum	6.00E-04 J	1.00E-02 J	mg/L	TCSW040, TCSW061, TCSW063, TCSW065, TCSW066, TCSW067	9 / 214	0.0004-0.1	1.00E-02	2.00E-02	1.00E-02 n	NA	NA	NO	BSL
	7440-02-0	Nickel	1.59E-03	1.10E+00	mg/L	M-SA	1193 / 1454	0.01-0.1	1.10E+00	2.00E-02	3.90E-02 n	NA	NA	YES	ASL
	7440-09-7	Potassium	5.00E-01 J	4.63E+01	mg/L	MR-UTD	965 / 1009	1-5	4.63E+01	9.76E+00	NA	NA	NA	NO	NUT
	7782-49-2	Selenium	4.00E-04 J	3.00E-03 J	mg/L	TCSW111	21 / 386	0.0004-0.035	3.00E-03	1.00E-02	1.00E-02 n	NA	NA	NO	BSL
	7631-86-9	Silica (as SIO2)	2.00E-01 J	4.41E+01	mg/L	TCSW110	116 / 118	0.5-0.5	4.41E+01	NA	NA	NA	NA	NO	NTX
	7440-22-4	Silver	1.90E-04 J	6.50E-04 LJ	mg/L	RVR0001-0011SW	7 / 374	0.0003-0.01	6.50E-04	1.00E-02	9.40E-03 n	NA	NA	NO	BSL
	7440-23-5	Sodium	1.94E+00	8.19E+02	mg/L	TCSW124	1420 / 1450	1-5	8.19E+02	1.20E+01	NA	NA	NA	NO	NUT
	7440-28-0	Thallium	1.00E-04 J	1.60E-03 J	mg/L	TCSW075	45 / 296	0.0001-0.025	1.60E-03	5.00E-03	2.00E-05 n	NA	NA	YES	ASL
	7440-62-2	Vanadium	4.00E-04 J	1.00E-02 J	mg/L	TCSW064, TCSW110, TCSW128	34 / 296	0.02-0.05	1.00E-02	2.00E-02	8.60E-03 n	NA	NA	YES	ASL
	7440-66-6	Zinc	2.87E-03	6.34E+01	mg/L	TCSW110	2115 / 2177	0.0005-0.0612	6.34E+01	3.10E-02	6.00E-01 n	NA	NA	YES	ASL

Notes:
(1) Maximum concentration is used for screening.
(2) Background values are the 95/95 Upper Tolerance Limit (UTL) for surface water from *Tar Creek Superfund Site Operable Unit 5 Ottawa County, Oklahoma Remedial Investigation Report* (April, 2019); values are for "total" metals.
(3) EPA RSL for tap water (November 2019) based on a target cancer risk of $1x10^{-6}$ and a non-cancer hazard quotient (HQ) of 0.1.
The RSL for Chromium(VI) was used for Chromium, total.
The RSL for Mercuric Chloride was used for Mercury.
(4) Rationale Codes:
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Below Screening Level (BSL)
Essential Nutrient (NUT)

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
G = Lead screening level based on blood lead modeling, as cited in Section 5.2 of RSL User's Guide
J = compound was detected below the reporting limit in the sample
LJ = result is estimated (low)
mg/L = milligram per liter
n = non-carcinogenic
NA = not available
RSL = Regional Screening Level

TABLE 2.3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue) - Tribal Lifeway

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (2)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion
Fish Tissue (Tribal Lifeway - Estimated Whole Fish Concentrations [1]) Sitewide	7429-90-5	Aluminum	6.10E-01		2.12E+01	J	mg/kg (w)	NR FS 02	80 / 80	-	NA	NA	NA	NA	NA	YES	--
	7440-36-0	Antimony	2.43E-01	J	3.20E-01	J	mg/kg (w)	LS FS 03	11 / 80	0.2317-0.4692	NA	NA	NA	NA	NA	YES	--
	7440-38-2	Arsenic	2.74E-01	J	7.24E-01		mg/kg (w)	NR FS 01	24 / 80	0.2658-0.722	NA	NA	NA	NA	NA	YES	--
	7440-39-3	Barium	1.78E-01		8.58E+00		mg/kg (w)	EC FS 05	80 / 80	-	NA	NA	NA	NA	NA	YES	--
	7440-41-7	Beryllium	1.00E-02		2.03E-02		mg/kg (w)	EC FS 05	16 / 80	0.01-0.01	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	3.00E-02	J	1.68E-01		mg/kg (w)	LS FS 02	69 / 80	0.03-0.03	NA	NA	NA	NA	NA	YES	--
	7440-47-3	Chromium	6.26E-02	J	1.07E+00		mg/kg (w)	TC FS 02	62 / 80	0.06-0.5406	NA	NA	NA	NA	NA	YES	--
	7440-48-4	Cobalt	3.23E-02	J	9.52E-02		mg/kg (w)	TC FS 05	51 / 80	0.03-0.04	NA	NA	NA	NA	NA	YES	--
	7440-50-8	Copper	2.12E-01		1.53E+00		mg/kg (w)	LC FS 01	59 / 80	0.2243-0.59	NA	NA	NA	NA	NA	YES	--
	7439-89-6	Iron	3.98E+00		2.72E+01		mg/kg (w)	EC FS 05	80 / 80	-	NA	NA	NA	NA	NA	YES	--
	7439-92-1	Lead	2.40E-01	J	2.86E+00		mg/kg (w)	LS FS 02	48 / 80	0.23-0.3309	NA	NA	NA	NA	NA	YES	--
	7439-96-5	Manganese	7.88E-01		4.63E+01		mg/kg (w)	TC FS 05	80 / 80	-	NA	NA	NA	NA	NA	YES	--
	7439-97-6	Mercury	7.04E-03		1.38E-01		mg/kg (w)	TC FS 05	80 / 80	-	NA	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	7.00E-02	J	2.56E-01		mg/kg (w)	TC FS 02	49 / 80	0.07-0.07	NA	NA	NA	NA	NA	YES	--
	7782-49-2	Selenium	7.34E-01	J	1.67E+00		mg/kg (w)	LS FS 02	22 / 80	0.7134-1.019	NA	NA	NA	NA	NA	YES	--
	7440-22-4	Silver	1.52E-01		5.87E-01		mg/kg (w)	LS FS 03	71 / 80	0.15-0.15	NA	NA	NA	NA	NA	YES	--
	7440-28-0	Thallium	3.13E-01	J	1.01E+00		mg/kg (w)	NR FS 03	28 / 80	0.3017-0.4309	NA	NA	NA	NA	NA	YES	--
	7440-62-2	Vanadium	1.42E-01	J	6.26E-01		mg/kg (w)	LS FS 02	30 / 80	0.14-0.2001	NA	NA	NA	NA	NA	YES	--
	7440-66-6	Zinc	9.99E+00		1.38E+02		mg/kg (w)	TC FS 05	80 / 80	-	NA	NA	NA	NA	NA	YES	--

Notes:
(1) Eviscerated whole fish concentration was estimated based on weighted concentrations of three fish body parts (carcass, filet, and head).
(2) Although fish samples were collected from the background reference area, background values were not established due to the limited number of background samples.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available

TABLE 2.4
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue) - General Public

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion
Fish Tissue (General Public - Game Fish Filet) Sitewide	7429-90-5	Aluminum	5.80E-01		4.74E+00	J	mg/kg (w)	TC FS 01	45 / 68	0.62-0.64	NA	NA	NA	NA	NA	YES	--
	7440-36-0	Antimony	3.00E-01	J	4.10E-01	J	mg/kg (w)	LS FS 03	4 / 68	0.23-0.47	NA	NA	NA	NA	NA	YES	--
	7440-38-2	Arsenic	2.80E-01	J	6.10E-01	J	mg/kg (w)	EC FS 05	6 / 68	0.27-0.57	NA	NA	NA	NA	NA	YES	--
	7440-39-3	Barium	1.00E-02	J	1.82E+00		mg/kg (w)	LC FS 03	50 / 68	0.01-0.18	NA	NA	NA	NA	NA	YES	--
	7440-41-7	Beryllium	1.00E-02		3.00E-02		mg/kg (w)	NR FS 01	10 / 68	0.01-0.01	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	3.00E-02	J	1.90E-01		mg/kg (w)	TC FS 01	22 / 101	0.02-0.03	NA	NA	NA	NA	NA	YES	--
	7440-47-3	Chromium	7.00E-02	J	1.16E+00		mg/kg (w)	TC FS 01	32 / 68	0.06-0.6	NA	NA	NA	NA	NA	YES	--
	7440-48-4	Cobalt	7.00E-02	J	7.00E-02	J	mg/kg (w)	EC FS 04	1 / 68	0.03-0.07	NA	NA	NA	NA	NA	YES	--
	7440-50-8	Copper	1.80E-01	J	1.40E+00		mg/kg (w)	LC FS 01	49 / 68	0.17-0.66	NA	NA	NA	NA	NA	YES	--
	7439-89-6	Iron	5.90E-01	J	1.82E+01		mg/kg (w)	TC FS 04	55 / 68	1.64-7.06	NA	NA	NA	NA	NA	YES	--
	7439-92-1	Lead	2.40E-01	J	9.90E-01		mg/kg (w)	TC FS 02	5 / 101	0.02-0.46	NA	NA	NA	NA	NA	YES	--
	7439-96-5	Manganese	8.00E-02		1.56E+01		mg/kg (w)	TC FS 02	68 / 68	-	NA	NA	NA	NA	NA	YES	--
	7439-97-6	Mercury	7.07E-03		1.72E-01		mg/kg (w)	TC FS 05	68 / 68	-	NA	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	7.00E-02	J	1.40E-01		mg/kg (w)	LC FS 01	11 / 68	0.07-0.14	NA	NA	NA	NA	NA	YES	--
	7782-49-2	Selenium	7.40E-01	J	1.52E+00		mg/kg (w)	NR FS 03	13 / 68	0.71-1.42	NA	NA	NA	NA	NA	YES	--
	7440-22-4	Silver	1.50E-01		2.30E-01		mg/kg (w)	LC FS 01	7 / 68	0.15-0.3	NA	NA	NA	NA	NA	YES	--
	7440-28-0	Thallium	5.50E-01	J	6.90E-01		mg/kg (w)	NR FS 03	2 / 68	0.3-0.6	NA	NA	NA	NA	NA	YES	--
	7440-66-6	Zinc	3.06E+00		9.48E+01		mg/kg (w)	TC FS 02	95 / 101	2.88-3.19	NA	NA	NA	NA	NA	YES	--

Notes:
(1) Although fish samples were collected from the background reference area, background values were not established due to the limited number of background samples.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available

TABLE 2.5
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue) - Tribal Lifeway

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion (2)
Shellfish Tissue Sitewide	7429-90-5	Aluminum	9.34E+00		3.10E+02		mg/kg (w)	BRSH1_KDHE	21 / 22	12.1-12.1	NA	NA	NA	NA	NA	YES	--
	7440-38-2	Arsenic	1.10E-01		2.04E+01	J	mg/kg (w)	LS MS 01	20 / 22	5.37-5.37	NA	NA	NA	NA	NA	YES	--
	7440-39-3	Barium	5.24E+00		1.01E+02		mg/kg (w)	LS MS 02	9 / 10	4.01-4.01	NA	NA	NA	NA	NA	YES	--
	7440-41-7	Beryllium	1.90E-01		3.80E-01		mg/kg (w)	LS MS 03	2 / 10	0.01-0.29	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	4.20E-02		1.60E+00		mg/kg (w)	LS MS 02	19 / 22	0.56-1.54	NA	NA	NA	NA	NA	YES	--
	7440-70-2	Calcium	3.90E+02		4.30E+03		mg/kg (w)	SPRNG6_KDHE	12 / 12	-	NA	NA	NA	NA	NA	NO	NUT
	7440-47-3	Chromium	6.60E-02		8.70E-01		mg/kg (w)	LS MS 01	18 / 22	1.23-3.4	NA	NA	NA	NA	NA	YES	--
	7440-48-4	Cobalt	5.00E-02	J	8.00E-02	J	mg/kg (w)	LS MS 01	4 / 10	0.04-1.89	NA	NA	NA	NA	NA	YES	--
	7440-50-8	Copper	4.40E-01		6.55E+00		mg/kg (w)	LS MS 03	21 / 22	3.52-3.52	NA	NA	NA	NA	NA	YES	--
	7439-89-6	Iron	2.92E+01	J	3.00E+02		mg/kg (w)	BRSH1_KDHE	22 / 22	-	NA	NA	NA	NA	NA	YES	--
	7439-92-1	Lead	2.30E-01		2.08E+01		mg/kg (w)	LS MS 01	19 / 22	0.24-4.67	NA	NA	NA	NA	NA	YES	--
	7439-95-4	Magnesium	5.80E+01		1.50E+02		mg/kg (w)	BRSH1_KDHE, SPRNG6_KDHE	12 / 12	-	NA	NA	NA	NA	NA	NO	NUT
	7439-96-5	Manganese	2.36E+00		1.54E+03		mg/kg (w)	LS MS 02,NR MS 02	22 / 22	-	NA	NA	NA	NA	NA	YES	--
	7439-97-6	Mercury	2.85E-03		1.81E-02		mg/kg (w)	LS MS 02	10 / 10	-	NA	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	1.00E-01		6.10E-01		mg/kg (w)	BRSH1_KDHE	18 / 22	1.4-3.89	NA	NA	NA	NA	NA	YES	--
	7440-09-7	Potassium	1.40E+02		3.40E+02		mg/kg (w)	SPRNG6_KDHE	12 / 12	-	NA	NA	NA	NA	NA	NO	NUT
	7782-49-2	Selenium	1.70E-01		3.26E+01		mg/kg (w)	LS MS 03	13 / 22	0.73-38.8	NA	NA	NA	NA	NA	YES	--
	7631-86-9	Silica (as SIO2)	1.40E+02		7.80E+02		mg/kg (w)	SPRNG6_KDHE	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7440-22-4	Silver	2.20E-01		7.20E-01		mg/kg (w)	LS MS 02	6 / 10	2.89-8.02	NA	NA	NA	NA	NA	YES	--
	7440-23-5	Sodium	2.20E+02		4.20E+02		mg/kg (w)	BRSH1_KDHE	12 / 12	-	NA	NA	NA	NA	NA	NO	NUT
	7440-66-6	Zinc	1.70E+01		1.08E+03		mg/kg (w)	LS MS 05	22 / 22	-	NA	NA	NA	NA	NA	YES	--

Notes:
(1) Although mussel samples were collected from the background reference area, background values were not established primarily due to the limited number of background samples.
(2) Rationale Codes:
Deletion Reason: Essential Nutrient (NUT)

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available

TABLE 2.6
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue) - Tribal Lifeway

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion
Aquatic Plants as Food (Arrowhead and Duckweed) Sitewide	7429-90-5	Aluminum	6.52E+01		7.94E+02		mg/kg (w)	EC AR 01	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7440-36-0	Antimony	3.70E-01	J	3.80E-01	J	mg/kg (w)	EC AR 01	2 / 12	0.24-0.24	NA	NA	NA	NA	NA	YES	--
	7440-38-2	Arsenic	3.50E-01	J	9.06E+00		mg/kg (w)	LS AR 01	13 / 17	0.27-0.27	NA	NA	NA	NA	NA	YES	--
	7440-39-3	Barium	2.70E+00		3.20E+01		mg/kg (w)	LC DW 02	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7440-41-7	Beryllium	2.00E-02		7.00E-02		mg/kg (w)	LC DW 01	6 / 12	0.01-0.01	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	5.00E-02	J	2.12E+01		mg/kg (w)	EC AR 01	17 / 17	-	NA	NA	NA	NA	NA	YES	--
	7440-47-3	Chromium	8.00E-02	J	4.31E+00		mg/kg (w)	EC AR 01	11 / 12	0.06-0.06	NA	NA	NA	NA	NA	YES	--
	7440-48-4	Cobalt	9.00E-02		7.91E+00		mg/kg (w)	LS AR 01	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7440-50-8	Copper	4.80E-01		2.27E+01		mg/kg (w)	EC AR 01	11 / 12	0.06-0.06	NA	NA	NA	NA	NA	YES	--
	7439-89-6	Iron	9.48E+01		1.21E+04		mg/kg (w)	LS AR 01	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7439-92-1	Lead	3.70E-01		8.38E+02	J	mg/kg (w)	EC AR 01	17 / 17	-	NA	NA	NA	NA	NA	YES	--
	7439-96-5	Manganese	1.44E+01		5.66E+02		mg/kg (w)	LC DW 02	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7439-97-6	Mercury	8.47E-04		9.36E-02		mg/kg (w)	EC AR 01	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	2.80E-01		3.58E+00		mg/kg (w)	EC AR 01	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7440-22-4	Silver	1.70E-01		1.70E-01		mg/kg (w)	LC DW 02	1 / 12	0.15-0.15	NA	NA	NA	NA	NA	YES	--
	7440-62-2	Vanadium	3.10E-01		5.05E+00		mg/kg (w)	LS AR 01	12 / 12	-	NA	NA	NA	NA	NA	YES	--
	7440-66-6	Zinc	8.87E+00		1.84E+03		mg/kg (w)	EC AR 01	17 / 17	-	NA	NA	NA	NA	NA	YES	--

Notes:
(1) Although an aquatic plant sample (duckweed) was collected from the background reference area, background values were not established due to the limited number of background samples.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available

TABLE 2.7
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue) - Tribal Lifeway

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion
Aquatic Plants as Salve (Arrowhead) Sitewide	7429-90-5	Aluminum	6.52E+01		7.94E+02		mg/kg (w)	EC AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7440-36-0	Antimony	3.70E-01	J	3.80E-01	J	mg/kg (w)	EC AR 01	2 / 9	0.24-0.24	NA	NA	NA	NA	NA	YES	--
	7440-38-2	Arsenic	3.50E-01	J	9.06E+00		mg/kg (w)	LS AR 01	8 / 11	0.27-0.27	NA	NA	NA	NA	NA	YES	--
	7440-39-3	Barium	2.70E+00		3.10E+01		mg/kg (w)	TC AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7440-41-7	Beryllium	2.00E-02		6.00E-02		mg/kg (w)	EC AR 01, LS AR 01, EC AR 01, LS AR 01	4 / 9	0.01-0.01	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	5.00E-02	J	2.12E+01		mg/kg (w)	EC AR 01	11 / 11	-	NA	NA	NA	NA	NA	YES	--
	7440-47-3	Chromium	8.00E-02	J	4.31E+00		mg/kg (w)	EC AR 01	8 / 9	0.06-0.06	NA	NA	NA	NA	NA	YES	--
	7440-48-4	Cobalt	9.00E-02		7.91E+00		mg/kg (w)	LS AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7440-50-8	Copper	4.80E-01		2.27E+01		mg/kg (w)	EC AR 01	8 / 9	0.06-0.06	NA	NA	NA	NA	NA	YES	--
	7439-89-6	Iron	9.48E+01		1.21E+04		mg/kg (w)	LS AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7439-92-1	Lead	4.30E-01	J	8.38E+02	J	mg/kg (w)	EC AR 01	11 / 11	-	NA	NA	NA	NA	NA	YES	--
	7439-96-5	Manganese	1.44E+01		5.31E+02		mg/kg (w)	LS AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7439-97-6	Mercury	8.47E-04		9.36E-02		mg/kg (w)	EC AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	3.00E-01		3.58E+00		mg/kg (w)	EC AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7440-62-2	Vanadium	3.10E-01		5.05E+00		mg/kg (w)	LS AR 01	9 / 9	-	NA	NA	NA	NA	NA	YES	--
	7440-66-6	Zinc	1.75E+01		1.84E+03		mg/kg (w)	EC AR 01	11 / 11	-	NA	NA	NA	NA	NA	YES	--

Notes:
(1) No aquatic plant samples (arrowhead) were collected from the background reference area.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available

TABLE 2.8
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue) - Tribal Lifeway

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion
Amphibian/Aquatic Reptile Tissue (Frog Legs) Sitewide	7429-90-5	Aluminum	6.70E-01		1.04E+01	J	mg/kg (w)	NR FG 03	9 / 14	0.63-0.64	NA	NA	NA	NA	NA	YES	--
	7440-38-2	Arsenic	2.80E-01	J	5.50E-01	J	mg/kg (w)	NR FG 02	3 / 14	0.27-0.27	NA	NA	NA	NA	NA	YES	--
	7440-39-3	Barium	1.09E+00		5.72E+00		mg/kg (w)	BC FG 03	14 / 14	-	NA	NA	NA	NA	NA	YES	--
	7440-41-7	Beryllium	1.00E-02		2.00E-02		mg/kg (w)	BC FG 04	2 / 14	0.01-0.01	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	3.00E-02	J	1.00E-01		mg/kg (w)	BC FG 02	10 / 14	0.03-0.03	NA	NA	NA	NA	NA	YES	--
	7440-47-3	Chromium	8.00E-02	J	1.05E+00		mg/kg (w)	NR FG 03	8 / 14	0.06-0.06	NA	NA	NA	NA	NA	YES	--
	7440-50-8	Copper	3.40E-01		1.20E+00		mg/kg (w)	NR FG 03	8 / 14	0.18-0.54	NA	NA	NA	NA	NA	YES	--
	7439-89-6	Iron	3.57E+00		1.32E+01		mg/kg (w)	NR FG 03	14 / 14	-	NA	NA	NA	NA	NA	YES	--
	7439-92-1	Lead	2.80E-01	J	1.92E+00		mg/kg (w)	BC FG 02	9 / 14	0.24-0.24	NA	NA	NA	NA	NA	YES	--
	7439-96-5	Manganese	1.08E+00		7.11E+00		mg/kg (w)	NR FG 02	14 / 14	-	NA	NA	NA	NA	NA	YES	--
	7439-97-6	Mercury	2.97E-03		2.38E-02		mg/kg (w)	LS FG 01	14 / 14	-	NA	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	1.00E-01		1.30E-01		mg/kg (w)	LS FG 02	2 / 14	0.07-0.07	NA	NA	NA	NA	NA	YES	--
	7782-49-2	Selenium	8.30E-01	J	8.30E-01	J	mg/kg (w)	BC FG 01	1 / 14	0.72-0.91	NA	NA	NA	NA	NA	YES	--
	7440-22-4	Silver	1.40E-01		3.50E-01		mg/kg (w)	LS FG 03	4 / 14	0.15-0.15	NA	NA	NA	NA	NA	YES	--
	7440-28-0	Thallium	5.00E-01	J	5.70E-01	J	mg/kg (w)	BC FG 02	2 / 14	0.3-0.31	NA	NA	NA	NA	NA	YES	--
	7440-66-6	Zinc	7.40E+00		4.15E+01		mg/kg (w)	TC FG 02	14 / 14	-	NA	NA	NA	NA	NA	YES	--

Notes:
(1) Although frog samples were collected from the background reference area, background values were not established due to the limited number of background samples.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available

TABLE 2.9
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue) - Tribal Lifeway

Exposure Point	CAS Number	Chemical	Minimum Concentration	Minimum Concentration Qualifier	Maximum Concentration	Maximum Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Background Value (1)	Screening Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for Selection or Deletion
Semi-Aquatic Mammals Tissue (Raccoon) Sitewide	7429-90-5	Aluminum	6.40E-01		1.40E+01		mg/kg (w)	BC RC 02	17 / 19	0.62-0.63	NA	NA	NA	NA	NA	YES	--
	7440-36-0	Antimony	3.10E-01	J	3.10E-01	J	mg/kg (w)	NR RC 03	1 / 19	0.24-0.24	NA	NA	NA	NA	NA	YES	--
	7440-38-2	Arsenic	3.90E-01	J	3.90E-01	J	mg/kg (w)	NR RC 06	1 / 19	0.27-0.27	NA	NA	NA	NA	NA	YES	--
	7440-39-3	Barium	3.00E-02	J	2.40E-01		mg/kg (w)	BC RC 02	12 / 19	0.01-0.2	NA	NA	NA	NA	NA	YES	--
	7440-41-7	Beryllium	4.00E-02		4.00E-02		mg/kg (w)	BC RC 02	1 / 19	0.01-0.01	NA	NA	NA	NA	NA	YES	--
	7440-43-9	Cadmium	3.00E-02	J	9.00E-02		mg/kg (w)	NR RC 06	8 / 19	0.03-0.03	NA	NA	NA	NA	NA	YES	--
	7440-47-3	Chromium	8.00E-02	J	8.80E-01		mg/kg (w)	NR RC 04	9 / 19	0.06-0.24	NA	NA	NA	NA	NA	YES	--
	7440-50-8	Copper	4.30E-01		2.17E+00		mg/kg (w)	LC RC 03	14 / 19	0.74-1.31	NA	NA	NA	NA	NA	YES	--
	7439-89-6	Iron	1.02E+01		6.59E+01		mg/kg (w)	BC RC 02	19 / 19	-	NA	NA	NA	NA	NA	YES	--
	7439-92-1	Lead	2.58E+00		5.17E+00		mg/kg (w)	EC RC 04	2 / 19	0.23-0.24	NA	NA	NA	NA	NA	YES	--
	7439-96-5	Manganese	1.10E-01		1.37E+00		mg/kg (w)	BC RC 02	15 / 19	0.1-0.23	NA	NA	NA	NA	NA	YES	--
	7439-97-6	Mercury	8.60E-04		1.37E-01		mg/kg (w)	LC RC 02	19 / 19	-	NA	NA	NA	NA	NA	YES	--
	7440-02-0	Nickel	3.70E-01		3.70E-01		mg/kg (w)	NR RC 04	1 / 19	0.07-0.07	NA	NA	NA	NA	NA	YES	--
	7782-49-2	Selenium	7.80E-01	J	9.30E-01	J	mg/kg (w)	LC RC 01	5 / 19	0.72-0.74	NA	NA	NA	NA	NA	YES	--
	7440-28-0	Thallium	3.50E-01	J	4.60E-01	J	mg/kg (w)	LC RC 01	2 / 19	0.3-0.31	NA	NA	NA	NA	NA	YES	--
	7440-66-6	Zinc	3.34E+01		6.12E+01		mg/kg (w)	EC RC 04	19 / 19	-	NA	NA	NA	NA	NA	YES	--

Notes:
(1) Although raccoon samples were collected from the background reference area, background values were not established due to the limited number of background samples.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
COPC = Chemical of Potential Concern
J = compound was detected below the reporting limit in the sample
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available

TABLE 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Sediment (Sieved) (0-12 inch deep) Elm Creek	Aluminum	mg/kg	5.4E+03	NA		1.1E+04	1.1E+04	mg/kg	Maximum	5
	Arsenic	mg/kg	6.5E+00	NA		1.0E+01	1.0E+01	mg/kg	Maximum	5
	Barium	mg/kg	2.9E+02	NA		4.3E+02	4.3E+02	mg/kg	Maximum	5
	Beryllium	mg/kg	1.5E+00	NA		2.0E+00	2.0E+00	mg/kg	Maximum	5
	Cadmium	mg/kg	2.6E+01	4.0E+01	N	8.0E+01	4.0E+01	mg/kg	95% Student's-t UCL	2
	Chromium	mg/kg	3.8E+01	NA		5.5E+01	5.5E+01	mg/kg	Maximum	5
	Cobalt	mg/kg	1.1E+01	NA		1.3E+01	1.3E+01	mg/kg	Maximum	5
	Copper	mg/kg	5.4E+01	NA		9.5E+01	9.5E+01	mg/kg	Maximum	5
	Iron	mg/kg	1.3E+04	NA		2.7E+04	2.7E+04	mg/kg	Maximum	5
	Lead	mg/kg	3.7E+02	5.8E+02		1.2E+03	3.7E+02	mg/kg	Arithmetic Mean	7
	Lithium	mg/kg	NA	NA		2.5E+01	2.5E+01	mg/kg	Maximum	5
	Manganese	mg/kg	3.7E+02	NA		5.2E+02	5.2E+02	mg/kg	Maximum	5
	Mercury	mg/kg	NA	NA		7.0E-02	7.0E-02	mg/kg	Maximum	5
	Nickel	mg/kg	2.4E+01	NA		2.5E+01	2.5E+01	mg/kg	Maximum	5
	Phosphorus	mg/kg	NA	NA		5.3E+02	5.3E+02	mg/kg	Maximum	5
	Selenium	mg/kg	NA	NA		8.0E-01	8.0E-01	mg/kg	Maximum	5
	Strontium	mg/kg	NA	NA		7.5E+01	7.5E+01	mg/kg	Maximum	5
	Vanadium	mg/kg	5.2E+01	NA		7.2E+01	7.2E+01	mg/kg	Maximum	5
	Zinc	mg/kg	1.4E+04	4.0E+05		1.1E+05	1.1E+05	mg/kg	Maximum	6

TABLE 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Sieved) (0-12 inch deep) Tar Creek	Aluminum	mg/kg	1.0E+04	1.4E+04		2.7E+04		1.4E+04	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Antimony	mg/kg	3.7E+01	7.3E+01		7.5E+02	J	7.3E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Arsenic	mg/kg	2.3E+01	4.6E+01		3.3E+02	J	4.6E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Barium	mg/kg	1.4E+02	1.7E+02	G	5.1E+02		1.7E+02	mg/kg	95% GROS Approximate Gamma UCL	3
	Beryllium	mg/kg	1.1E+00	1.2E+00	L	2.2E+00		1.2E+00	mg/kg	KM H-UCL	1
	Cadmium	mg/kg	1.5E+02	3.6E+02		4.2E+03		3.6E+02	mg/kg	95% KM (Chebyshev) UCL	4
	Chromium	mg/kg	2.4E+01	3.3E+01		1.1E+02		3.3E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Cobalt	mg/kg	1.9E+01	3.8E+01		3.9E+02		3.8E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Copper	mg/kg	5.8E+01	8.6E+01		3.2E+02		8.6E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Iron	mg/kg	4.5E+04	9.3E+04		5.0E+05		9.3E+04	mg/kg	97.5% Chebyshev (Mean, Sd) UCL	4
	Lead	mg/kg	1.1E+03	1.7E+03		7.3E+03	J	1.1E+03	mg/kg	Arithmetic Mean	7
	Lithium	mg/kg	3.6E+01	4.1E+01	N	4.8E+01		4.1E+01	mg/kg	95% Student's-t UCL	2
	Manganese	mg/kg	8.1E+02	9.0E+02	L	1.1E+04		9.0E+02	mg/kg	95% H-UCL	1
	Mercury	mg/kg	2.4E-01	2.4E-01	G	1.1E+00		2.4E-01	mg/kg	95% KM Approximate Gamma UCL	3
	Molybdenum	mg/kg	1.2E+01	1.5E+01		1.1E+02		1.5E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Nickel	mg/kg	4.7E+01	4.8E+01	L	1.1E+03		4.8E+01	mg/kg	95% H-UCL	1
	Phosphorus	mg/kg	8.9E+02	1.1E+03	N	1.5E+03		1.1E+03	mg/kg	95% Student's-t UCL	2
	Selenium	mg/kg	2.9E+00	5.2E+00		5.0E+01	J	5.2E+00	mg/kg	95% KM (Chebyshev) UCL	4
	Silica (as SIO2)	mg/kg	4.4E+03	4.7E+03	N	7.8E+03	J	4.7E+03	mg/kg	95% Student's-t UCL	2
	Silver	mg/kg	3.5E-01	8.1E-01		9.8E+00		8.1E-01	mg/kg	95% KM (Chebyshev) UCL	4
	Strontium	mg/kg	7.9E+01	8.9E+01	N	1.1E+02		8.9E+01	mg/kg	95% Student's-t UCL	2
	Thallium	mg/kg	5.3E-01	9.8E-01		5.3E+00		9.8E-01	mg/kg	95% KM (Chebyshev) UCL	4
	Vanadium	mg/kg	5.2E+01	6.2E+01	N	1.0E+02		6.2E+01	mg/kg	95% Student's-t UCL	2
	Zinc	mg/kg	1.5E+04	2.1E+04	G	6.4E+04		2.1E+04	mg/kg	95% Adjusted Gamma UCL	3

TABLE 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Sediment (Sieved) (0-12 inch deep) Neosho River	Aluminum	mg/kg	NA	NA	1.9E+04	1.9E+04	mg/kg	Maximum	5
	Arsenic	mg/kg	NA	NA	9.8E+00	9.8E+00	mg/kg	Maximum	5
	Barium	mg/kg	NA	NA	1.9E+02 J	1.9E+02	mg/kg	Maximum	5
	Beryllium	mg/kg	NA	NA	1.3E+00	1.3E+00	mg/kg	Maximum	5
	Cadmium	mg/kg	3.3E+00	NA	6.2E+00	6.2E+00	mg/kg	Maximum	5
	Chromium	mg/kg	NA	NA	2.4E+01	2.4E+01	mg/kg	Maximum	5
	Cobalt	mg/kg	NA	NA	1.5E+01	1.5E+01	mg/kg	Maximum	5
	Copper	mg/kg	NA	NA	1.5E+01	1.5E+01	mg/kg	Maximum	5
	Iron	mg/kg	NA	NA	2.6E+04	2.6E+04	mg/kg	Maximum	5
	Lead	mg/kg	3.8E+01	NA	1.0E+02	3.8E+01	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	NA	NA	8.6E+02	8.6E+02	mg/kg	Maximum	5
	Nickel	mg/kg	NA	NA	2.5E+01	2.5E+01	mg/kg	Maximum	5
	Vanadium	mg/kg	NA	NA	4.1E+01	4.1E+01	mg/kg	Maximum	5
	Zinc	mg/kg	2.9E+02	NA	4.8E+02	4.8E+02	mg/kg	Maximum	5

TABLE 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Sieved) (0-12 inch deep) Beaver Creek	Aluminum	mg/kg	1.0E+04	1.2E+04	N	1.8E+04		1.2E+04	mg/kg	95% Student's-t UCL	2
	Antimony	mg/kg	5.5E-01	7.6E-01	N	1.2E+00	J	7.6E-01	mg/kg	95% KM (t) UCL	2
	Arsenic	mg/kg	1.9E+01	2.5E+01	N	5.0E+01		2.5E+01	mg/kg	95% Student's-t UCL	2
	Barium	mg/kg	1.4E+02	1.7E+02	N	2.2E+02	J	1.7E+02	mg/kg	95% Student's-t UCL	2
	Beryllium	mg/kg	1.0E+00	1.1E+00	N	2.0E+00	J	1.1E+00	mg/kg	95% KM (t) UCL	2
	Cadmium	mg/kg	3.9E+01	9.8E+01		2.4E+02		9.8E+01	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Chromium	mg/kg	2.7E+01	5.7E+01		1.2E+02		5.7E+01	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Cobalt	mg/kg	1.8E+01	2.2E+01	N	3.8E+01		2.2E+01	mg/kg	95% Student's-t UCL	2
	Copper	mg/kg	1.3E+01	1.5E+01	N	2.1E+01		1.5E+01	mg/kg	95% Student's-t UCL	2
	Iron	mg/kg	2.6E+04	3.3E+04	L	8.7E+04		3.3E+04	mg/kg	95% H-UCL	1
	Lead	mg/kg	2.7E+02	3.6E+02		8.8E+02	J	2.7E+02	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	1.3E+03	2.3E+03	G	4.6E+03		2.3E+03	mg/kg	95% Adjusted Gamma UCL	3
	Mercury	mg/kg	1.1E-01	1.5E-01	N	1.9E-01	J	1.5E-01	mg/kg	95% KM (t) UCL	2
	Molybdenum	mg/kg	2.7E+00	3.5E+00	G	5.0E+00		3.5E+00	mg/kg	95% KM Adjusted Gamma UCL	3
	Nickel	mg/kg	2.6E+01	3.4E+01	N	6.0E+01		3.4E+01	mg/kg	95% Student's-t UCL	2
	Selenium	mg/kg	7.5E-01	NA		8.0E-01	J	8.0E-01	mg/kg	Maximum	5
	Silica (as SIO2)	mg/kg	5.3E+03	6.0E+03	N	7.3E+03	J	6.0E+03	mg/kg	95% Student's-t UCL	2
	Silver	mg/kg	1.5E-01	3.7E-01		8.0E-01	J	3.7E-01	mg/kg	95% KM (Chebyshev) UCL	4
	Thallium	mg/kg	5.5E-01	1.3E+00		2.9E+00	J	1.3E+00	mg/kg	95% KM (Chebyshev) UCL	4
	Vanadium	mg/kg	NA	NA		2.2E+01		2.2E+01	mg/kg	Maximum	5
	Zinc	mg/kg	5.0E+03	NA		6.3E+03	J	6.3E+03	mg/kg	Maximum	5

TABLE 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)		Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Sediment (Sieved) (0-12 inch deep) Lost Creek	Aluminum	mg/kg	1.0E+04	NA	1.4E+04		1.4E+04	mg/kg	Maximum	5
	Arsenic	mg/kg	3.3E+00	NA	4.0E+00		4.0E+00	mg/kg	Maximum	5
	Barium	mg/kg	1.2E+02	NA	1.3E+02		1.3E+02	mg/kg	Maximum	5
	Cadmium	mg/kg	3.7E+00	1.4E+01	2.5E+01		1.4E+01	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Chromium	mg/kg	2.5E+01	NA	2.8E+01		2.8E+01	mg/kg	Maximum	5
	Cobalt	mg/kg	NA	NA	9.6E+00		9.6E+00	mg/kg	Maximum	5
	Copper	mg/kg	8.7E+00	NA	1.1E+01		1.1E+01	mg/kg	Maximum	5
	Iron	mg/kg	1.4E+04	NA	1.7E+04		1.7E+04	mg/kg	Maximum	5
	Lead	mg/kg	1.7E+02	7.9E+02	1.5E+03	J	1.7E+02	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	1.3E+03	NA	2.6E+03	J	2.6E+03	mg/kg	Maximum	5
	Nickel	mg/kg	1.4E+01	NA	1.5E+01		1.5E+01	mg/kg	Maximum	5
	Vanadium	mg/kg	2.3E+01	NA	2.4E+01		2.4E+01	mg/kg	Maximum	5
	Zinc	mg/kg	5.5E+02	2.0E+03	3.4E+03	J	2.0E+03	mg/kg	95% Chebyshev (Mean, Sd) UCL	4

TABLE 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Sieved) (0-12 inch deep) Lower Spring River	Aluminum	mg/kg	5.9E+03	8.0E+03		2.2E+04		8.0E+03	mg/kg	95% Hall's Bootstrap UCL	4
	Arsenic	mg/kg	1.2E+01	1.6E+01		3.0E+01		1.6E+01	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Barium	mg/kg	3.0E+02	4.2E+02		5.5E+02		4.2E+02	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Beryllium	mg/kg	1.6E+00	2.0E+00		4.0E+00		2.0E+00	mg/kg	95% KM (Chebyshev) UCL	4
	Boron	mg/kg	1.4E+01	1.2E+01	L	6.4E+01		1.2E+01	mg/kg	KM H-UCL	1
	Cadmium	mg/kg	1.5E+01	2.1E+01	L	1.8E+02		2.1E+01	mg/kg	95% H-UCL	1
	Chromium	mg/kg	5.5E+01	6.2E+01	N	1.6E+02		6.2E+01	mg/kg	95% Student's-t UCL	2
	Cobalt	mg/kg	1.9E+01	2.2E+01	N	4.9E+01		2.2E+01	mg/kg	95% Student's-t UCL	2
	Copper	mg/kg	2.2E+01	2.4E+01	G	7.5E+01		2.4E+01	mg/kg	95% Adjusted Gamma UCL	3
	Iron	mg/kg	1.5E+04	1.9E+04		6.1E+04		1.9E+04	mg/kg	95% Hall's Bootstrap UCL	4
	Lead	mg/kg	1.5E+02	1.8E+02		8.1E+02		1.5E+02	mg/kg	Arithmetic Mean	7
	Lithium	mg/kg	4.9E+01	5.5E+01	N	8.2E+01		5.5E+01	mg/kg	95% Student's-t UCL	2
	Manganese	mg/kg	9.4E+02	1.1E+03	G	2.5E+03		1.1E+03	mg/kg	95% Adjusted Gamma UCL	3
	Mercury	mg/kg	7.3E-02	9.7E-02	L	2.9E-01		9.7E-02	mg/kg	KM H-UCL	1
	Molybdenum	mg/kg	1.6E+00	1.4E+00		4.0E+00		1.4E+00	mg/kg	95% KM (BCA) UCL	4
	Nickel	mg/kg	3.3E+01	3.6E+01	N	8.9E+01		3.6E+01	mg/kg	95% Student's-t UCL	2
	Phosphorus	mg/kg	8.6E+02	9.7E+02		1.7E+03		9.7E+02	mg/kg	95% Modified-t UCL	4
	Selenium	mg/kg	1.5E+00	1.9E+00		5.0E+00		1.9E+00	mg/kg	95% KM (Chebyshev) UCL	4
	Silica (as SIO2)	mg/kg	1.6E+03	2.2E+03	G	5.6E+03		2.2E+03	mg/kg	95% Adjusted Gamma UCL	3
	Silver	mg/kg	NA	NA		8.0E-02	J	8.0E-02	mg/kg	Maximum	5
	Strontium	mg/kg	9.9E+01	1.1E+02	N	1.4E+02		1.1E+02	mg/kg	95% Student's-t UCL	2
	Thallium	mg/kg	NA	NA		8.0E-02	J	8.0E-02	mg/kg	Maximum	5
	Vanadium	mg/kg	6.0E+01	8.3E+01		1.3E+02		8.3E+01	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Zinc	mg/kg	2.0E+03	3.6E+03		1.6E+04		3.6E+03	mg/kg	95% Chebyshev (Mean, Sd) UCL	4

TABLE 3.1.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:

Statistics: Maximum - Maximum detected value
Adjusted Gamma - UCL adjusted for level significance assuming gamma distribution
Chebyshev (mean, Sd) - nonparametric UCL using sample mean and standard deviation based on the Chebyshev inequality
GROS Approximate Gamma - UCL approximation based on the regression on order statistics (ROS) method for a gamma distribution
Hall's Bootstrap - nonparametric UCL
H-UCL - UCL based upon Land's H-statistic assuming lognormal distribution
KM (BCA) - nonparametric UCL based upon Kaplan-Meier estimates using the bias-corrected accelerated bootstrap method
KM (Chebyshev) - nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Adjusted Gamma - UCL based upon Kaplan-Meier estimates, adjusted for level significance assuming gamma distribution
KM Approximate Gamma - UCL based upon Kaplan-Meier estimates, calculated using chi-square approximation assuming gamma distribution
KM H-UCL - UCL based upon Kaplan-Meier estimates using Land's H-statistic assuming lognormal distribution
Modified-t - nonparametric UCL adjusted for skewness
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(5) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(6) The maximum detected concentration was used as the EPC because the UCL exceeded the maximum detected concentration.
(7) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
L = Log-normal distribution
mg/kg = milligram per kilogram
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Unsieved) (0-12 inch deep) Elm Creek	Aluminum	mg/kg	7.1E+03	8.1E+03	N	1.6E+04		8.1E+03	mg/kg	95% Student's-t UCL	2
	Antimony	mg/kg	3.3E+00	3.6E+00	G	9.2E+00		3.6E+00	mg/kg	95% KM Adjusted Gamma UCL	3
	Arsenic	mg/kg	8.5E+00	1.1E+01	L	3.4E+01	J	1.1E+01	mg/kg	KM H-UCL	1
	Barium	mg/kg	8.5E+01	1.0E+02	G	2.7E+02		1.0E+02	mg/kg	95% Adjusted Gamma UCL	3
	Beryllium	mg/kg	9.0E-01	9.6E-01	N	2.1E+00		9.6E-01	mg/kg	95% KM (t) UCL	2
	Cadmium	mg/kg	6.0E+01	1.2E+02	G	6.5E+02	J	1.2E+02	mg/kg	Gamma Adjusted KM-UCL	3
	Chromium	mg/kg	1.7E+01	2.6E+01		4.8E+01		2.6E+01	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Cobalt	mg/kg	1.3E+01	1.5E+01	G	3.4E+01		1.5E+01	mg/kg	95% KM Adjusted Gamma UCL	3
	Copper	mg/kg	1.3E+02	2.1E+02	G	7.6E+02	J	2.1E+02	mg/kg	95% Adjusted Gamma UCL	3
	Iron	mg/kg	2.2E+04	2.7E+04	G	7.4E+04		2.7E+04	mg/kg	95% Adjusted Gamma UCL	3
	Lead	mg/kg	4.3E+03	1.5E+04		4.0E+04	J	4.3E+03	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	4.8E+02	6.4E+02	G	2.1E+03		6.4E+02	mg/kg	95% Adjusted Gamma UCL	3
	Mercury	mg/kg	3.5E-01	4.9E-01	G	2.1E+00		4.9E-01	mg/kg	Gamma Adjusted KM-UCL	3
	Nickel	mg/kg	2.6E+01	2.9E+01	N	6.2E+01		2.9E+01	mg/kg	95% KM (t) UCL	2
	Selenium	mg/kg	7.7E+00	6.9E+00	G	1.7E+01		6.9E+00	mg/kg	95% KM Adjusted Gamma UCL	3
	Silver	mg/kg	6.8E-01	5.3E-01	G	1.5E+00		5.3E-01	mg/kg	Gamma Adjusted KM-UCL	3
	Thallium	mg/kg	1.3E+00	1.0E+00	G	3.8E+00		1.0E+00	mg/kg	Gamma Adjusted KM-UCL	3
	Vanadium	mg/kg	2.5E+01	2.8E+01	N	5.4E+01		2.8E+01	mg/kg	95% Student's-t UCL	2
	Zinc	mg/kg	1.3E+04	3.3E+04		1.3E+05		3.3E+04	mg/kg	95% Chebyshev (Mean, Sd) UCL	4

TABLE 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Unsieved) (0-12 inch deep) Tar Creek	Aluminum	mg/kg	3.3E+03	4.1E+03	G	1.6E+04		4.1E+03	mg/kg	95% Approximate Gamma UCL	3
	Antimony	mg/kg	1.1E+00	1.3E+00	N	2.5E+00	LJ	1.3E+00	mg/kg	95% KM (t) UCL	2
	Arsenic	mg/kg	9.6E+00	1.4E+01		4.6E+01		1.4E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Barium	mg/kg	7.9E+01	6.2E+01	N	1.9E+02		6.2E+01	mg/kg	95% KM (t) UCL	2
	Beryllium	mg/kg	9.6E-01	7.3E-01	N	2.1E+00		7.3E-01	mg/kg	95% KM (t) UCL	2
	Cadmium	mg/kg	4.7E+01	7.5E+01	L	2.4E+02	J	7.5E+01	mg/kg	KM H-UCL	1
	Chromium	mg/kg	1.4E+01	1.6E+01	L	1.4E+02		1.6E+01	mg/kg	KM H-UCL	1
	Cobalt	mg/kg	2.0E+01	2.3E+01		1.0E+02		2.3E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Copper	mg/kg	3.1E+01	5.3E+01		3.1E+02	J	5.3E+01	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Iron	mg/kg	3.1E+04	3.9E+04	G	2.0E+05	J	3.9E+04	mg/kg	95% Approximate Gamma UCL	3
	Lead	mg/kg	5.3E+02	8.0E+02		4.9E+03		5.3E+02	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	4.6E+02	5.8E+02	L	8.9E+03		5.8E+02	mg/kg	95% H-UCL	1
	Mercury	mg/kg	3.1E-01	2.3E-01	N	9.0E-01	J^	2.3E-01	mg/kg	95% KM (t) UCL	2
	Molybdenum	mg/kg	4.0E+01	NA		1.0E+02		1.0E+02	mg/kg	Maximum	5
	Nickel	mg/kg	3.5E+01	4.1E+01	G	2.0E+02		4.1E+01	mg/kg	95% GROS Approximate Gamma UCL	3
	Selenium	mg/kg	5.8E+00	3.1E+00	G	1.4E+01		3.1E+00	mg/kg	95% KM Approximate Gamma UCL	3
	Silver	mg/kg	3.7E+00	9.2E-01	N	8.0E+00		9.2E-01	mg/kg	95% KM (t) UCL	2
	Thallium	mg/kg	NA	NA		2.8E-01	LJ	2.8E-01	mg/kg	Maximum	5
	Vanadium	mg/kg	2.1E+01	1.8E+01	G	5.6E+01		1.8E+01	mg/kg	95% GROS Approximate Gamma UCL	3
	Zinc	mg/kg	8.2E+03	1.2E+04		4.3E+04	J	1.2E+04	mg/kg	95% Chebyshev (Mean, Sd) UCL	4

TABLE 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Unsieved) (0-12 inch deep) Neosho River	Aluminum	mg/kg	1.3E+04	1.6E+04	N	2.8E+04		1.6E+04	mg/kg	95% Student's-t UCL	2
	Arsenic	mg/kg	8.1E+00	9.0E+00	N	1.3E+01		9.0E+00	mg/kg	95% KM (t) UCL	2
	Barium	mg/kg	1.0E+02	1.2E+02	N	1.8E+02	J	1.2E+02	mg/kg	95% Student's-t UCL	2
	Beryllium	mg/kg	1.1E+00	1.2E+00	N	2.0E+00		1.2E+00	mg/kg	95% KM (t) UCL	2
	Cadmium	mg/kg	1.1E+00	1.8E+00	L	1.7E+00		1.7E+00	mg/kg	Maximum	6
	Chromium	mg/kg	1.7E+01	2.1E+01	N	3.9E+01		2.1E+01	mg/kg	95% Student's-t UCL	2
	Cobalt	mg/kg	2.9E+01	7.2E+01		1.0E+02		7.2E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Copper	mg/kg	8.3E+00	9.9E+00	N	1.9E+01		9.9E+00	mg/kg	95% Student's-t UCL	2
	Iron	mg/kg	1.3E+04	1.5E+04	N	2.1E+04		1.5E+04	mg/kg	95% Student's-t UCL	2
	Lead	mg/kg	1.3E+01	1.7E+01		3.2E+01		1.3E+01	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	4.3E+02	5.5E+02	G	9.0E+02	J	5.5E+02	mg/kg	95% Adjusted Gamma UCL	3
	Mercury	mg/kg	NA	NA		8.4E-03		8.4E-03	mg/kg	Maximum	5
	Molybdenum	mg/kg	5.5E+01	NA		1.0E+02		1.0E+02	mg/kg	Maximum	5
	Nickel	mg/kg	1.4E+01	1.5E+01	N	2.3E+01	J	1.5E+01	mg/kg	95% KM (t) UCL	2
	Selenium	mg/kg	9.9E+00	NA		1.4E+01		1.4E+01	mg/kg	Maximum	5
	Silver	mg/kg	5.0E+00	NA		8.0E+00		8.0E+00	mg/kg	Maximum	5
	Vanadium	mg/kg	2.1E+01	NA		3.4E+01		3.4E+01	mg/kg	Maximum	5
	Zinc	mg/kg	1.2E+02	1.5E+02	N	2.6E+02		1.5E+02	mg/kg	95% Student's-t UCL	2

TABLE 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Unsieved) (0-12 inch deep) Beaver Creek	Aluminum	mg/kg	3.4E+03	4.4E+03	N	1.1E+04		4.4E+03	mg/kg	95% Student's-t UCL	2
	Antimony	mg/kg	1.5E+00	NA		3.0E+00	LJ	3.0E+00	mg/kg	Maximum	5
	Arsenic	mg/kg	8.6E+00	1.0E+01	N	2.0E+01		1.0E+01	mg/kg	95% Student's-t UCL	2
	Barium	mg/kg	9.7E+01	1.9E+02	G	2.7E+02		1.9E+02	mg/kg	95% GROS Adjusted Gamma UCL	3
	Beryllium	mg/kg	8.4E-01	9.8E-01	N	2.0E+00		9.8E-01	mg/kg	95% KM (t) UCL	2
	Cadmium	mg/kg	4.1E+01	1.5E+02		5.5E+02	J	1.5E+02	mg/kg	95% KM (Chebyshev) UCL	4
	Chromium	mg/kg	2.1E+01	2.5E+01	N	4.9E+01		2.5E+01	mg/kg	95% KM (t) UCL	2
	Cobalt	mg/kg	1.9E+01	2.1E+01	L	1.0E+02		2.1E+01	mg/kg	KM H-UCL	1
	Copper	mg/kg	8.9E+00	1.2E+01	G	4.8E+01	J	1.2E+01	mg/kg	95% Adjusted Gamma UCL	3
	Iron	mg/kg	1.8E+04	2.2E+04	N	4.0E+04		2.2E+04	mg/kg	95% Student's-t UCL	2
	Lead	mg/kg	9.5E+01	1.5E+02		5.9E+02	J	9.5E+01	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	4.2E+02	5.5E+02	N	1.5E+03	J	5.5E+02	mg/kg	95% Student's-t UCL	2
	Mercury	mg/kg	3.8E-01	4.7E-01		1.1E+00		4.7E-01	mg/kg	95% KM (Chebyshev) UCL	4
	Molybdenum	mg/kg	5.5E+01	NA		1.0E+02		1.0E+02	mg/kg	Maximum	5
	Nickel	mg/kg	1.6E+01	1.9E+01	N	3.5E+01		1.9E+01	mg/kg	95% KM (t) UCL	2
	Selenium	mg/kg	1.3E+01	NA		1.4E+01		1.4E+01	mg/kg	Maximum	5
	Silver	mg/kg	5.0E+00	NA		8.0E+00		8.0E+00	mg/kg	Maximum	5
	Vanadium	mg/kg	3.1E+01	3.3E+01	N	6.1E+01		3.3E+01	mg/kg	95% KM (t) UCL	2
	Zinc	mg/kg	6.2E+03	2.4E+04		8.8E+04	J	2.4E+04	mg/kg	95% Chebyshev (Mean, Sd) UCL	4

TABLE 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Unsieved) (0-12 inch deep) Lost Creek	Aluminum	mg/kg	5.3E+03	6.4E+03	G	1.5E+04		6.4E+03	mg/kg	95% Adjusted Gamma UCL	3
	Antimony	mg/kg	1.7E+00	3.6E+00		7.1E+00		3.6E+00	mg/kg	95% KM (Chebyshev) UCL	4
	Arsenic	mg/kg	4.7E+00	4.6E+00	N	8.6E+00		4.6E+00	mg/kg	95% KM (t) UCL	2
	Barium	mg/kg	7.8E+01	8.7E+01	N	1.8E+02		8.7E+01	mg/kg	95% KM (t) UCL	2
	Beryllium	mg/kg	8.9E-01	8.0E-01		1.4E+00		8.0E-01	mg/kg	95% KM (BCA) UCL	4
	Cadmium	mg/kg	5.7E+00	1.0E+01	L	3.8E+01		1.0E+01	mg/kg	KM H-UCL	1
	Chromium	mg/kg	2.7E+01	3.3E+01	G	8.5E+01	J	3.3E+01	mg/kg	95% Adjusted Gamma UCL	3
	Cobalt	mg/kg	8.4E+00	8.1E+00	N	1.3E+01		8.1E+00	mg/kg	95% KM (t) UCL	2
	Copper	mg/kg	6.3E+00	6.7E+00	N	1.4E+01		6.7E+00	mg/kg	95% KM (t) UCL	2
	Iron	mg/kg	1.3E+04	1.4E+04	N	2.7E+04		1.4E+04	mg/kg	95% Student's-t UCL	2
	Lead	mg/kg	1.2E+02	3.6E+02		1.5E+03	J	1.2E+02	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	6.9E+02	9.1E+02	L	4.8E+03		9.1E+02	mg/kg	95% H-UCL	1
	Mercury	mg/kg	5.8E-01	1.4E+00		6.5E+00	J	1.4E+00	mg/kg	97.5% KM (Chebyshev) UCL	4
	Nickel	mg/kg	9.6E+00	9.2E+00	N	1.9E+01		9.2E+00	mg/kg	95% KM (t) UCL	2
	Selenium	mg/kg	5.5E+00	3.8E+00	N	9.2E+00	J	3.8E+00	mg/kg	95% KM (t) UCL	2
	Silver	mg/kg	NA	NA		1.2E+00		1.2E+00	mg/kg	Maximum	5
	Thallium	mg/kg	NA	NA		3.0E+00		3.0E+00	mg/kg	Maximum	5
	Vanadium	mg/kg	2.6E+01	2.9E+01	N	6.5E+01		2.9E+01	mg/kg	95% Student's-t UCL	2
	Zinc	mg/kg	5.4E+02	8.0E+02	L	4.7E+03		8.0E+02	mg/kg	95% H-UCL	1

TABLE 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Sediment (Unsieved) (0-12 inch deep) Lower Spring River	Aluminum	mg/kg	6.6E+03	7.6E+03	N	1.9E+04		7.6E+03	mg/kg	95% Student's-t UCL	2
	Antimony	mg/kg	1.9E+00	2.0E+00	N	3.2E+00	J	2.0E+00	mg/kg	95% KM (t) UCL	2
	Arsenic	mg/kg	9.1E+00	1.1E+01	G	3.9E+01		1.1E+01	mg/kg	95% Adjusted Gamma UCL	3
	Barium	mg/kg	8.7E+01	9.6E+01	G	2.5E+02		9.6E+01	mg/kg	95% GROS Adjusted Gamma UCL	3
	Beryllium	mg/kg	1.4E+00	1.7E+00		4.1E+00		1.7E+00	mg/kg	95% KM (Chebyshev) UCL	4
	Cadmium	mg/kg	8.7E+00	3.9E+01	L	5.3E+01		3.9E+01	mg/kg	KM H-UCL	1
	Chromium	mg/kg	2.9E+01	3.5E+01	L	1.5E+02		3.5E+01	mg/kg	95% H-UCL	1
	Cobalt	mg/kg	1.7E+01	2.6E+01		1.0E+02		2.6E+01	mg/kg	95% KM (Chebyshev) UCL	4
	Copper	mg/kg	1.3E+01	1.6E+01	G	8.2E+01		1.6E+01	mg/kg	95% Adjusted Gamma UCL	3
	Iron	mg/kg	2.9E+04	4.9E+04		1.5E+05		4.9E+04	mg/kg	95% Chebyshev (Mean, Sd) UCL	4
	Lead	mg/kg	1.1E+02	1.3E+02		1.1E+03	J	1.1E+02	mg/kg	Arithmetic Mean	7
	Manganese	mg/kg	5.4E+02	6.5E+02	G	1.9E+03		6.5E+02	mg/kg	95% Adjusted Gamma UCL	3
	Mercury	mg/kg	1.8E-01	1.7E-01	G	1.1E+00		1.7E-01	mg/kg	Gamma Adjusted KM-UCL	3
	Molybdenum	mg/kg	5.5E+01	NA		1.0E+02		1.0E+02	mg/kg	Maximum	5
	Nickel	mg/kg	2.6E+01	2.9E+01	G	8.8E+01		2.9E+01	mg/kg	95% GROS Adjusted Gamma UCL	3
	Selenium	mg/kg	1.8E+01	6.3E+00	N	3.0E+01		6.3E+00	mg/kg	95% KM (t) UCL	2
	Silver	mg/kg	5.0E+00	NA		8.0E+00		8.0E+00	mg/kg	Maximum	5
	Vanadium	mg/kg	3.1E+01	3.6E+01		9.0E+01		3.6E+01	mg/kg	95% Modified-t UCL	4
	Zinc	mg/kg	1.2E+03	1.5E+03	G	7.0E+03		1.5E+03	mg/kg	95% Adjusted Gamma UCL	3

TABLE 3.2.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:

Statistics: Maximum - Maximum detected value
Adjusted Gamma - UCL adjusted for level significance assuming gamma distribution
Approximate Gamma - UCL calculated using chi-square approximation assuming gamma distribution
Chebyshev (mean, Sd) - nonparametric UCL using sample mean and standard deviation based on the Chebyshev inequality
GROS Adjusted Gamma - UCL based on the regression on order statistics (ROS) method, adjusted for level significance assuming gamma distribution
GROS Approximate Gamma - UCL approximation based on the regression on order statistics (ROS) method for a gamma distribution
H-UCL - UCL based upon Land's H-statistic assuming lognormal distribution
KM (BCA) - nonparametric UCL based upon Kaplan-Meier estimates using the bias-corrected accelerated bootstrap method
KM (Chebyshev) - nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Adjusted Gamma - UCL based upon Kaplan-Meier estimates, adjusted for level significance assuming gamma distribution
KM Approximate Gamma - UCL based upon Kaplan-Meier estimates, calculated using chi-square approximation assuming gamma distribution
KM H-UCL - UCL based upon Kaplan-Meier estimates using Land's H-statistic assuming lognormal distribution
Modified-t - nonparametric UCL adjusted for skewness
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(5) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(6) The maximum detected concentration was used as the EPC because the UCL exceeded the maximum detected concentration.
(7) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
J^ = result is estimated (high)
L = log-normal distribution
LJ = result is estimated (low)
mg/kg = milligram per kilogram
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.2.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

			Sieved Sediment EPC		Unsieved Sediment EPC		Maximum EPC of Sieved or Unsieved Sediment	
Exposure Point	Chemical of Potential Concern	Units	Value	Statistic	Value	Statistic	Value	Soil Depth
Sediment (0-12 inch deep) Elm Creek	Aluminum	mg/kg	1.08E+04	Maximum	8.14E+03	95% Student's-t UCL	1.08E+04	Sieved
	Antimony	mg/kg	NA	NA	3.65E+00	95% KM Adjusted Gamma UCL	3.65E+00	Unsieved
	Arsenic	mg/kg	1.00E+01	Maximum	1.14E+01	KM H-UCL	1.14E+01	Unsieved
	Barium	mg/kg	4.30E+02	Maximum	1.04E+02	95% Adjusted Gamma UCL	4.30E+02	Sieved
	Beryllium	mg/kg	2.00E+00	Maximum	9.64E-01	95% KM (t) UCL	2.00E+00	Sieved
	Cadmium	mg/kg	3.99E+01	95% Student's-t UCL	1.17E+02	Gamma Adjusted KM-UCL	1.17E+02	Unsieved
	Chromium	mg/kg	5.50E+01	Maximum	2.58E+01	95% Chebyshev (Mean, Sd) UCL	5.50E+01	Sieved
	Cobalt	mg/kg	1.30E+01	Maximum	1.49E+01	95% KM Adjusted Gamma UCL	1.49E+01	Unsieved
	Copper	mg/kg	9.53E+01	Maximum	2.13E+02	95% Adjusted Gamma UCL	2.13E+02	Unsieved
	Iron	mg/kg	2.68E+04	Maximum	2.73E+04	95% Adjusted Gamma UCL	2.73E+04	Unsieved
	Lead	mg/kg	3.67E+02	Arithmetic Mean	4.28E+03	Arithmetic Mean	4.28E+03	Unsieved
	Lithium	mg/kg	2.50E+01	Maximum	NA	NA	2.50E+01	Sieved
	Manganese	mg/kg	5.20E+02	Maximum	6.38E+02	95% Adjusted Gamma UCL	6.38E+02	Unsieved
	Mercury	mg/kg	7.00E-02	Maximum	4.92E-01	Gamma Adjusted KM-UCL	4.92E-01	Unsieved
	Nickel	mg/kg	2.50E+01	Maximum	2.94E+01	95% KM (t) UCL	2.94E+01	Unsieved
	Phosphorus	mg/kg	5.30E+02	Maximum	NA	NA	5.30E+02	Sieved
	Selenium	mg/kg	8.00E-01	Maximum	6.88E+00	95% KM Adjusted Gamma UCL	6.88E+00	Unsieved
	Silver	mg/kg	NA	NA	5.26E-01	Gamma Adjusted KM-UCL	5.26E-01	Unsieved
	Strontium	mg/kg	7.50E+01	Maximum	NA	NA	7.50E+01	Sieved
	Thallium	mg/kg	NA	NA	9.98E-01	Gamma Adjusted KM-UCL	9.98E-01	Unsieved
	Vanadium	mg/kg	7.20E+01	Maximum	2.80E+01	95% Student's-t UCL	7.20E+01	Sieved
	Zinc	mg/kg	1.09E+05	Maximum	3.31E+04	95% Chebyshev (Mean, Sd) UCL	1.09E+05	Sieved

TABLE 3.2.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

			Sieved Sediment EPC		Unsieved Sediment EPC		Maximum EPC of Sieved or Unsieved Sediment	
Exposure Point	Chemical of Potential Concern	Units	Value	Statistic	Value	Statistic	Value	Soil Depth
Sediment (0-12 inch deep) Tar Creek	Aluminum	mg/kg	1.38E+04	95% Chebyshev (Mean, Sd) UCL	4.11E+03	95% Approximate Gamma UCL	1.38E+04	Sieved
	Antimony	mg/kg	7.30E+01	95% KM (Chebyshev) UCL	1.33E+00	95% KM (t) UCL	7.30E+01	Sieved
	Arsenic	mg/kg	4.56E+01	95% KM (Chebyshev) UCL	1.35E+01	95% KM (Chebyshev) UCL	4.56E+01	Sieved
	Barium	mg/kg	1.68E+02	95% GROS Approximate Gamma UCL	6.20E+01	95% KM (t) UCL	1.68E+02	Sieved
	Beryllium	mg/kg	1.23E+00	KM H-UCL	7.25E-01	95% KM (t) UCL	1.23E+00	Sieved
	Cadmium	mg/kg	3.57E+02	95% KM (Chebyshev) UCL	7.46E+01	KM H-UCL	3.57E+02	Sieved
	Chromium	mg/kg	3.35E+01	95% KM (Chebyshev) UCL	1.63E+01	KM H-UCL	3.35E+01	Sieved
	Cobalt	mg/kg	3.79E+01	95% KM (Chebyshev) UCL	2.32E+01	95% KM (Chebyshev) UCL	3.79E+01	Sieved
	Copper	mg/kg	8.63E+01	95% KM (Chebyshev) UCL	5.34E+01	95% Chebyshev (Mean, Sd) UCL	8.63E+01	Sieved
	Iron	mg/kg	9.34E+04	97.5% Chebyshev (Mean, Sd) UCL	3.88E+04	95% Approximate Gamma UCL	9.34E+04	Sieved
	Lead	mg/kg	1.10E+03	Arithmetic Mean	5.32E+02	Arithmetic Mean	1.10E+03	Sieved
	Lithium	mg/kg	4.07E+01	95% Student's-t UCL	NA	NA	4.07E+01	Sieved
	Manganese	mg/kg	9.04E+02	95% H-UCL	5.81E+02	95% H-UCL	9.04E+02	Sieved
	Mercury	mg/kg	2.35E-01	95% KM Approximate Gamma UCL	2.26E-01	95% KM (t) UCL	2.35E-01	Sieved
	Molybdenum	mg/kg	1.48E+01	95% KM (Chebyshev) UCL	1.00E+02	Maximum	1.00E+02	Unsieved
	Nickel	mg/kg	4.78E+01	95% H-UCL	4.07E+01	95% GROS Approximate Gamma UCL	4.78E+01	Sieved
	Phosphorus	mg/kg	1.09E+03	95% Student's-t UCL	NA	NA	1.09E+03	Sieved
	Selenium	mg/kg	5.17E+00	95% KM (Chebyshev) UCL	3.10E+00	95% KM Approximate Gamma UCL	5.17E+00	Sieved
	Silica (as SIO2)	mg/kg	4.70E+03	95% Student's-t UCL	NA	NA	4.70E+03	Sieved
	Silver	mg/kg	8.12E-01	95% KM (Chebyshev) UCL	9.18E-01	95% KM (t) UCL	9.18E-01	Unsieved
	Strontium	mg/kg	8.86E+01	95% Student's-t UCL	NA	NA	8.86E+01	Sieved
	Thallium	mg/kg	9.82E-01	95% KM (Chebyshev) UCL	2.80E-01	Maximum	9.82E-01	Sieved
	Vanadium	mg/kg	6.21E+01	95% Student's-t UCL	1.79E+01	95% GROS Approximate Gamma UCL	6.21E+01	Sieved
	Zinc	mg/kg	2.14E+04	95% Adjusted Gamma UCL	1.23E+04	95% Chebyshev (Mean, Sd) UCL	2.14E+04	Sieved

TABLE 3.2.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

			Sieved Sediment EPC		Unsieved Sediment EPC		Maximum EPC of Sieved or Unsieved Sediment	
Exposure Point	Chemical of Potential Concern	Units	Value	Statistic	Value	Statistic	Value	Soil Depth
Sediment (0-12 inch deep) Neosho River	Aluminum	mg/kg	1.88E+04	Maximum	1.65E+04	95% Student's-t UCL	1.88E+04	Sieved
	Arsenic	mg/kg	9.79E+00	Maximum	9.03E+00	95% KM (t) UCL	9.79E+00	Sieved
	Barium	mg/kg	1.88E+02	Maximum	1.24E+02	95% Student's-t UCL	1.88E+02	Sieved
	Beryllium	mg/kg	1.32E+00	Maximum	1.23E+00	95% KM (t) UCL	1.32E+00	Sieved
	Cadmium	mg/kg	6.20E+00	Maximum	1.70E+00	Maximum	6.20E+00	Sieved
	Chromium	mg/kg	2.37E+01	Maximum	2.11E+01	95% Student's-t UCL	2.37E+01	Sieved
	Cobalt	mg/kg	1.51E+01	Maximum	7.24E+01	95% KM (Chebyshev) UCL	7.24E+01	Unsieved
	Copper	mg/kg	1.46E+01	Maximum	9.87E+00	95% Student's-t UCL	1.46E+01	Sieved
	Iron	mg/kg	2.60E+04	Maximum	1.49E+04	95% Student's-t UCL	2.60E+04	Sieved
	Lead	mg/kg	3.78E+01	Arithmetic Mean	1.31E+01	Arithmetic Mean	3.78E+01	Sieved
	Manganese	mg/kg	8.56E+02	Maximum	5.49E+02	95% Adjusted Gamma UCL	8.56E+02	Sieved
	Mercury	mg/kg	NA	NA	8.41E-03	Maximum	8.41E-03	Unsieved
	Molybdenum	mg/kg	NA	NA	1.00E+02	Maximum	1.00E+02	Unsieved
	Nickel	mg/kg	2.49E+01	Maximum	1.51E+01	95% KM (t) UCL	2.49E+01	Sieved
	Selenium	mg/kg	NA	NA	1.40E+01	Maximum	1.40E+01	Unsieved
	Silver	mg/kg	NA	NA	8.00E+00	Maximum	8.00E+00	Unsieved
	Vanadium	mg/kg	4.08E+01	Maximum	3.43E+01	Maximum	4.08E+01	Sieved
	Zinc	mg/kg	4.78E+02	Maximum	1.52E+02	95% Student's-t UCL	4.78E+02	Sieved

TABLE 3.2.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

			Sieved Sediment EPC		Unsieved Sediment EPC		Maximum EPC of Sieved or Unsieved Sediment	
Exposure Point	Chemical of Potential Concern	Units	Value	Statistic	Value	Statistic	Value	Soil Depth
Sediment (0-12 inch deep) Beaver Creek	Aluminum	mg/kg	1.20E+04	95% Student's-t UCL	4.45E+03	95% Student's-t UCL	1.20E+04	Sieved
	Antimony	mg/kg	7.61E-01	95% KM (t) UCL	3.00E+00	Maximum	3.00E+00	Unsieved
	Arsenic	mg/kg	2.51E+01	95% Student's-t UCL	9.99E+00	95% Student's-t UCL	2.51E+01	Sieved
	Barium	mg/kg	1.66E+02	95% Student's-t UCL	1.85E+02	95% GROS Adjusted Gamma UCL	1.85E+02	Unsieved
	Beryllium	mg/kg	1.15E+00	95% KM (t) UCL	9.80E-01	95% KM (t) UCL	1.15E+00	Sieved
	Cadmium	mg/kg	9.84E+01	95% Chebyshev (Mean, Sd) UCL	1.49E+02	95% KM (Chebyshev) UCL	1.49E+02	Unsieved
	Chromium	mg/kg	5.69E+01	95% Chebyshev (Mean, Sd) UCL	2.54E+01	95% KM (t) UCL	5.69E+01	Sieved
	Cobalt	mg/kg	2.21E+01	95% Student's-t UCL	2.11E+01	KM H-UCL	2.21E+01	Sieved
	Copper	mg/kg	1.49E+01	95% Student's-t UCL	1.22E+01	95% Adjusted Gamma UCL	1.49E+01	Sieved
	Iron	mg/kg	3.33E+04	95% H-UCL	2.25E+04	95% Student's-t UCL	3.33E+04	Sieved
	Lead	mg/kg	2.75E+02	Arithmetic Mean	9.49E+01	Arithmetic Mean	2.75E+02	Sieved
	Manganese	mg/kg	2.26E+03	95% Adjusted Gamma UCL	5.52E+02	95% Student's-t UCL	2.26E+03	Sieved
	Mercury	mg/kg	1.49E-01	95% KM (t) UCL	4.68E-01	95% KM (Chebyshev) UCL	4.68E-01	Unsieved
	Molybdenum	mg/kg	3.46E+00	95% KM Adjusted Gamma UCL	1.00E+02	Maximum	1.00E+02	Unsieved
	Nickel	mg/kg	3.38E+01	95% Student's-t UCL	1.89E+01	95% KM (t) UCL	3.38E+01	Sieved
	Selenium	mg/kg	8.00E-01	Maximum	1.40E+01	Maximum	1.40E+01	Unsieved
	Silica (as SIO2)	mg/kg	6.04E+03	95% Student's-t UCL	NA	NA	6.04E+03	Sieved
	Silver	mg/kg	3.73E-01	95% KM (Chebyshev) UCL	8.00E+00	Maximum	8.00E+00	Unsieved
	Thallium	mg/kg	1.27E+00	95% KM (Chebyshev) UCL	NA	NA	1.27E+00	Sieved
	Vanadium	mg/kg	2.15E+01	Maximum	3.30E+01	95% KM (t) UCL	3.30E+01	Unsieved
	Zinc	mg/kg	6.27E+03	Maximum	2.38E+04	95% Chebyshev (Mean, Sd) UCL	2.38E+04	Unsieved

TABLE 3.2.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

			Sieved Sediment EPC		Unsieved Sediment EPC		Maximum EPC of Sieved or Unsieved Sediment	
Exposure Point	Chemical of Potential Concern	Units	Value	Statistic	Value	Statistic	Value	Soil Depth
Sediment (0-12 inch deep) Lost Creek	Aluminum	mg/kg	1.37E+04	Maximum	6.39E+03	95% Adjusted Gamma UCL	1.37E+04	Sieved
	Antimony	mg/kg	NA	NA	3.63E+00	95% KM (Chebyshev) UCL	3.63E+00	Unsieved
	Arsenic	mg/kg	4.00E+00	Maximum	4.61E+00	95% KM (t) UCL	4.61E+00	Unsieved
	Barium	mg/kg	1.30E+02	Maximum	8.71E+01	95% KM (t) UCL	1.30E+02	Sieved
	Beryllium	mg/kg	NA	NA	8.04E-01	95% KM (BCA) UCL	8.04E-01	Unsieved
	Cadmium	mg/kg	1.43E+01	95% Chebyshev (Mean, Sd) UCL	1.01E+01	KM H-UCL	1.43E+01	Sieved
	Chromium	mg/kg	2.84E+01	Maximum	3.31E+01	95% Adjusted Gamma UCL	3.31E+01	Unsieved
	Cobalt	mg/kg	9.64E+00	Maximum	8.13E+00	95% KM (t) UCL	9.64E+00	Sieved
	Copper	mg/kg	1.07E+01	Maximum	6.70E+00	95% KM (t) UCL	1.07E+01	Sieved
	Iron	mg/kg	1.67E+04	Maximum	1.43E+04	95% Student's-t UCL	1.67E+04	Sieved
	Lead	mg/kg	1.68E+02	Arithmetic Mean	1.24E+02	Arithmetic Mean	1.68E+02	Sieved
	Manganese	mg/kg	2.57E+03	Maximum	9.09E+02	95% H-UCL	2.57E+03	Sieved
	Mercury	mg/kg	NA	NA	1.40E+00	97.5% KM (Chebyshev) UCL	1.40E+00	Unsieved
	Nickel	mg/kg	1.50E+01	Maximum	9.22E+00	95% KM (t) UCL	1.50E+01	Sieved
	Selenium	mg/kg	NA	NA	3.77E+00	95% KM (t) UCL	3.77E+00	Unsieved
	Silver	mg/kg	NA	NA	1.18E+00	Maximum	1.18E+00	Unsieved
	Thallium	mg/kg	NA	NA	2.96E+00	Maximum	2.96E+00	Unsieved
	Vanadium	mg/kg	2.38E+01	Maximum	2.94E+01	95% Student's-t UCL	2.94E+01	Unsieved
	Zinc	mg/kg	1.96E+03	95% Chebyshev (Mean, Sd) UCL	8.03E+02	95% H-UCL	1.96E+03	Sieved

TABLE 3.2.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

			Sieved Sediment EPC		Unsieved Sediment EPC		Maximum EPC of Sieved or Unsieved Sediment	
Exposure Point	Chemical of Potential Concern	Units	Value	Statistic	Value	Statistic	Value	Soil Depth
Sediment (0-12 inch deep) Lower Spring River	Aluminum	mg/kg	7.98E+03	95% Hall's Bootstrap UCL	7.60E+03	95% Student's-t UCL	7.98E+03	Sieved
	Antimony	mg/kg	NA	NA	1.95E+00	95% KM (t) UCL	1.95E+00	Unsieved
	Arsenic	mg/kg	1.64E+01	95% Chebyshev (Mean, Sd) UCL	1.13E+01	95% Adjusted Gamma UCL	1.64E+01	Sieved
	Barium	mg/kg	4.21E+02	95% Chebyshev (Mean, Sd) UCL	9.59E+01	95% GROS Adjusted Gamma UCL	4.21E+02	Sieved
	Beryllium	mg/kg	2.05E+00	95% KM (Chebyshev) UCL	1.66E+00	95% KM (Chebyshev) UCL	2.05E+00	Sieved
	Boron	mg/kg	1.22E+01	KM H-UCL	NA	NA	1.22E+01	Sieved
	Cadmium	mg/kg	2.10E+01	95% H-UCL	3.92E+01	KM H-UCL	3.92E+01	Unsieved
	Chromium	mg/kg	6.23E+01	95% Student's-t UCL	3.55E+01	95% H-UCL	6.23E+01	Sieved
	Cobalt	mg/kg	2.15E+01	95% Student's-t UCL	2.61E+01	95% KM (Chebyshev) UCL	2.61E+01	Unsieved
	Copper	mg/kg	2.44E+01	95% Adjusted Gamma UCL	1.60E+01	95% Adjusted Gamma UCL	2.44E+01	Sieved
	Iron	mg/kg	1.93E+04	95% Hall's Bootstrap UCL	4.90E+04	95% Chebyshev (Mean, Sd) UCL	4.90E+04	Unsieved
	Lead	mg/kg	1.46E+02	Arithmetic Mean	1.08E+02	Arithmetic Mean	1.46E+02	Sieved
	Lithium	mg/kg	5.47E+01	95% Student's-t UCL	NA	NA	5.47E+01	Sieved
	Manganese	mg/kg	1.08E+03	95% Adjusted Gamma UCL	6.46E+02	95% Adjusted Gamma UCL	1.08E+03	Sieved
	Mercury	mg/kg	9.67E-02	KM H-UCL	1.71E-01	Gamma Adjusted KM-UCL	1.71E-01	Unsieved
	Molybdenum	mg/kg	1.36E+00	95% KM (BCA) UCL	1.00E+02	Maximum	1.00E+02	Unsieved
	Nickel	mg/kg	3.65E+01	95% Student's-t UCL	2.91E+01	95% GROS Adjusted Gamma UCL	3.65E+01	Sieved
	Phosphorus	mg/kg	9.66E+02	95% Modified-t UCL	NA	NA	9.66E+02	Sieved
	Selenium	mg/kg	1.94E+00	95% KM (Chebyshev) UCL	6.26E+00	95% KM (t) UCL	6.26E+00	Unsieved
	Silica (as SIO2)	mg/kg	2.24E+03	95% Adjusted Gamma UCL	NA	NA	2.24E+03	Sieved
	Silver	mg/kg	8.00E-02	Maximum	8.00E+00	Maximum	8.00E+00	Unsieved
	Strontium	mg/kg	1.08E+02	95% Student's-t UCL	NA	NA	1.08E+02	Sieved
	Thallium	mg/kg	8.00E-02	Maximum	NA	NA	8.00E-02	Sieved
	Vanadium	mg/kg	8.27E+01	95% Chebyshev (Mean, Sd) UCL	3.63E+01	95% Modified-t UCL	8.27E+01	Sieved
	Zinc	mg/kg	3.60E+03	95% Chebyshev (Mean, Sd) UCL	1.50E+03	95% Adjusted Gamma UCL	3.60E+03	Sieved

Notes:

EPC = Exposure Point Concentration

TABLE 3.2.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

			Sieved Sediment EPC		Unsieved Sediment EPC		Maximum EPC of Sieved or Unsieved Sediment	
Exposure Point	Chemical of Potential Concern	Units	Value	Statistic	Value	Statistic	Value	Soil Depth

mg/kg = milligram per kilogram

NA = not available or not applicable

UCL = Upper Confidence Limit

Statistics: Maximum = Maximum detected value
Adjusted Gamma = UCL adjusted for level significance assuming gamma distribution
Approximate Gamma = UCL calculated using chi-square approximation assuming gamma distribution
Chebyshev (mean, Sd) = nonparametric UCL using sample mean and standard deviation based on the Chebyshev inequality
GROS Adjusted Gamma = UCL based on the regression on order statistics (ROS) method, adjusted for level significance assuming gamma distribution
GROS Approximate Gamma = UCL approximation based on the regression on order statistics (ROS) method for a gamma distribution
H-UCL = UCL based upon Land's H-statistic assuming lognormal distribution
KM (BCA) = nonparametric UCL based upon Kaplan-Meier estimates using the bias-corrected accelerated bootstrap method
KM (Chebyshev) = nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) = UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Adjusted Gamma = UCL based upon Kaplan-Meier estimates, adjusted for level significance assuming gamma distribution
KM Approximate Gamma = UCL based upon Kaplan-Meier estimates, calculated using chi-square approximation assuming gamma distribution
KM H-UCL = UCL based upon Kaplan-Meier estimates using Land's H-statistic assuming lognormal distribution
Modified-t = nonparametric UCL adjusted for skewness
Student's-t = UCL based on Student's t statistic assuming normal distribution

TABLE 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Surface Water Elm Creek	Aluminum	mg/L	6.2E-01	7.2E-01	G	3.4E+00		7.2E-01	mg/L	Gamma Adjusted KM-UCL	3
	Antimony	mg/L	2.2E-03	NA		2.2E-03	LJ	2.2E-03	mg/L	Maximum	5
	Arsenic	mg/L	2.0E-03	NA		3.1E-03	LJ	3.1E-03	mg/L	Maximum	5
	Barium	mg/L	6.3E-02	7.1E-02	G	1.2E-01		7.1E-02	mg/L	95% KM Adjusted Gamma UCL	3
	Cadmium	mg/L	3.2E-02	3.9E-02	G	1.6E-01		3.9E-02	mg/L	Gamma Adjusted KM-UCL	3
	Chromium	mg/L	3.2E-03	2.8E-03	L	1.2E-02		2.8E-03	mg/L	KM H-UCL	1
	Cobalt	mg/L	2.1E-03	9.5E-03	G	7.8E-03	LJ	7.8E-03	mg/L	Maximum	6
	Copper	mg/L	1.0E-02	1.4E-02		3.7E-02		1.4E-02	mg/L	95% KM (Chebyshev) UCL	4
	Iron	mg/L	7.4E-01	9.4E-01	G	3.8E+00		9.4E-01	mg/L	95% KM Adjusted Gamma UCL	3
	Lead	mg/L	6.4E-02	2.3E-01		4.5E-01		6.4E-02	mg/L	Arithmetic Mean	7
	Manganese	mg/L	4.9E-01	6.6E-01	G	3.2E+00		6.6E-01	mg/L	95% Adjusted Gamma UCL	3
	Nickel	mg/L	1.7E-02	1.9E-02	N	3.3E-02		1.9E-02	mg/L	95% KM (t) UCL	2
	Selenium	mg/L	NA	NA		5.0E-04	J	5.0E-04	mg/L	Maximum	5
	Vanadium	mg/L	1.4E-03	NA		2.2E-03	LJ	2.2E-03	mg/L	Maximum	5
	Zinc	mg/L	5.2E+00	6.7E+00	G	2.4E+01		6.7E+00	mg/L	Gamma Adjusted KM-UCL	3

TABLE 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Surface Water Tar Creek	Aluminum	mg/L	4.2E-01	4.7E-01		7.4E+00		4.7E-01	mg/L	95% KM (Chebyshev) UCL	4
	Antimony	mg/L	2.6E-03	5.7E-04		3.3E-03	LJ	5.7E-04	mg/L	95% KM (Chebyshev) UCL	4
	Arsenic	mg/L	4.2E-02	3.4E-02		2.3E-01		3.4E-02	mg/L	95% KM (Chebyshev) UCL	4
	Barium	mg/L	4.7E-02	5.0E-02	L	1.7E-01		5.0E-02	mg/L	KM H-UCL	1
	Beryllium	mg/L	2.4E-04	NA		2.8E-04	LJ	2.8E-04	mg/L	Maximum	5
	Cadmium	mg/L	1.4E-02	1.6E-02		3.6E-01		1.6E-02	mg/L	95% KM (Chebyshev) UCL	4
	Chromium	mg/L	3.4E-03	3.7E-03		6.1E-02		3.7E-03	mg/L	95% KM (Chebyshev) UCL	4
	Cobalt	mg/L	3.1E-02	3.2E-02		1.2E-01		3.2E-02	mg/L	95% KM (Chebyshev) UCL	4
	Copper	mg/L	5.2E-03	6.1E-03		2.2E-01		6.1E-03	mg/L	95% KM (Chebyshev) UCL	4
	Iron	mg/L	4.3E+01	5.1E+01		2.6E+02		5.1E+01	mg/L	95% KM (Chebyshev) UCL	4
	Lead	mg/L	3.7E-02	4.4E-02		1.3E+00		3.7E-02	mg/L	Arithmetic Mean	7
	Manganese	mg/L	1.4E+00	1.6E+00		1.2E+01		1.6E+00	mg/L	95% KM (Chebyshev) UCL	4
	Mercury	mg/L	1.8E-04	5.8E-05	N	6.0E-04	J	5.8E-05	mg/L	95% KM (t) UCL	2
	Molybdenum	mg/L	1.0E-02	NA		1.0E-02	J	1.0E-02	mg/L	Maximum	6
	Nickel	mg/L	3.2E-01	3.3E-01		1.1E+00		3.3E-01	mg/L	95% KM (Chebyshev) UCL	4
	Selenium	mg/L	2.0E-03	8.1E-04	N	3.0E-03	J	8.1E-04	mg/L	95% KM (t) UCL	2
	Silica (as SIO2)	mg/L	1.4E+01	1.6E+01	L	4.4E+01		1.6E+01	mg/L	KM H-UCL	1
	Silver	mg/L	4.7E-04	2.2E-04	N	6.5E-04	LJ	2.2E-04	mg/L	95% KM (t) UCL	2
	Thallium	mg/L	2.3E-04	2.3E-04		1.0E-03		2.3E-04	mg/L	95% KM (Chebyshev) UCL	4
	Vanadium	mg/L	7.2E-03	8.2E-03		1.0E-02	J	8.2E-03	mg/L	95% KM (BCA) UCL	4
	Zinc	mg/L	5.7E+00	6.3E+00		6.3E+01		6.3E+00	mg/L	95% KM (Chebyshev) UCL	4

TABLE 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Surface Water Neosho River	Aluminum	mg/L	5.8E+00	8.7E+00	G	4.0E+01		8.7E+00	mg/L	95% Adjusted Gamma UCL	3
	Arsenic	mg/L	5.3E-03	3.6E-03	G	1.4E-02		3.6E-03	mg/L	Gamma Adjusted KM-UCL	3
	Barium	mg/L	1.4E-01	1.6E-01	L	4.0E-01		1.6E-01	mg/L	KM H-UCL	1
	Cadmium	mg/L	1.1E-03	3.8E-04	N	1.7E-03		3.8E-04	mg/L	95% KM (t) UCL	2
	Chromium	mg/L	1.2E-02	9.0E-03	N	4.1E-02		9.0E-03	mg/L	95% KM (t) UCL	2
	Cobalt	mg/L	7.3E-03	4.6E-03	N	2.0E-02		4.6E-03	mg/L	95% KM (t) UCL	2
	Copper	mg/L	1.3E-02	1.3E-02	L	4.5E-02		1.3E-02	mg/L	KM H-UCL	1
	Iron	mg/L	4.6E+00	6.9E+00	G	2.7E+01		6.9E+00	mg/L	Gamma Adjusted KM-UCL	3
	Lead	mg/L	4.5E-03	3.7E-03		2.1E-02		4.5E-03	mg/L	Arithmetic Mean	7
	Manganese	mg/L	2.0E-01	2.5E-01	G	1.2E+00		2.5E-01	mg/L	95% Adjusted Gamma UCL	3
	Molybdenum	mg/L	NA	NA		8.0E-04	J	8.0E-04	mg/L	Maximum	5
	Nickel	mg/L	1.0E-02	9.4E-03	N	2.7E-02		9.4E-03	mg/L	95% KM (t) UCL	2
	Selenium	mg/L	5.0E-04	NA		5.0E-04	J	5.0E-04	mg/L	Maximum	5
	Vanadium	mg/L	3.8E-03	8.3E-03		5.1E-03		5.1E-03	mg/L	Maximum	6
	Zinc	mg/L	3.7E-02	7.6E-02		6.9E-01		7.6E-02	mg/L	95% KM (Chebyshev) UCL	4

TABLE 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Surface Water Beaver Creek	Aluminum	mg/L	8.4E-01	1.4E+00		1.9E+01		1.4E+00	mg/L	95% KM (Chebyshev) UCL	4
	Arsenic	mg/L	3.5E-03	8.4E-03	G	1.2E-02		8.4E-03	mg/L	95% GROS Approximate Gamma UCL	3
	Barium	mg/L	7.0E-02	7.5E-02	N	1.8E-01		7.5E-02	mg/L	95% KM (t) UCL	2
	Cadmium	mg/L	2.1E-03	1.8E-03	L	3.2E-02		1.8E-03	mg/L	KM H-UCL	1
	Chromium	mg/L	4.1E-03	3.3E-03	L	1.8E-02		3.3E-03	mg/L	KM H-UCL	1
	Cobalt	mg/L	2.6E-03	7.9E-03	G	9.9E-03		7.9E-03	mg/L	95% GROS Approximate Gamma UCL	3
	Copper	mg/L	4.7E-03	6.4E-03		4.9E-02		6.4E-03	mg/L	95% KM (Chebyshev) UCL	4
	Iron	mg/L	1.3E+00	1.8E+00	L	1.5E+01		1.8E+00	mg/L	KM H-UCL	1
	Lead	mg/L	1.1E-02	1.3E-02		1.0E-01		1.1E-02	mg/L	Arithmetic Mean	7
	Manganese	mg/L	1.8E-01	2.3E-01		1.1E+00		2.3E-01	mg/L	95% KM (Chebyshev) UCL	4
	Nickel	mg/L	1.5E-02	1.5E-02	N	3.2E-02		1.5E-02	mg/L	95% KM (t) UCL	2
	Selenium	mg/L	1.5E-03	NA		2.0E-03		2.0E-03	mg/L	Maximum	5
	Silica (as SIO2)	mg/L	1.1E+01	1.5E+01		2.3E+01		1.5E+01	mg/L	95% KM (Chebyshev) UCL	4
	Silver	mg/L	NA	NA		3.4E-04	LJ	3.4E-04	mg/L	Maximum	5
	Thallium	mg/L	5.7E-04	4.1E-04	N	1.6E-03	J	4.1E-04	mg/L	95% KM (t) UCL	2
	Vanadium	mg/L	5.1E-03	7.4E-03	N	1.0E-02	J	7.4E-03	mg/L	95% KM (t) UCL	2
	Zinc	mg/L	5.4E-01	5.9E-01	G	3.7E+00		5.9E-01	mg/L	95% KM Approximate Gamma UCL	3

TABLE 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Surface Water Lost Creek	Aluminum	mg/L	3.7E-01	3.6E-01	N	6.8E-01		3.6E-01	mg/L	95% KM (t) UCL	2
	Barium	mg/L	6.6E-02	7.2E-02	N	7.9E-02		7.2E-02	mg/L	95% KM (t) UCL	2
	Cadmium	mg/L	3.7E-05	3.7E-05	N	4.9E-05		3.7E-05	mg/L	95% KM (t) UCL	2
	Copper	mg/L	NA	NA		5.0E-02		5.0E-02	mg/L	Maximum	5
	Iron	mg/L	2.7E-01	3.2E-01	N	6.5E-01		3.2E-01	mg/L	95% KM (t) UCL	2
	Lead	mg/L	1.2E-01	1.4E-03		1.2E-02		1.2E-01	mg/L	Arithmetic Mean	7
	Manganese	mg/L	8.0E-02	1.2E-01	L	3.3E-01		1.2E-01	mg/L	KM H-UCL	1
	Nickel	mg/L	NA	NA		1.8E-03		1.8E-03	mg/L	Maximum	5
	Vanadium	mg/L	NA	NA		4.0E-04	J	4.0E-04	mg/L	Maximum	5
	Zinc	mg/L	3.5E-02	4.6E-02		4.1E-01		4.6E-02	mg/L	95% KM (Chebyshev) UCL	4

TABLE 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Surface Water Lower Spring River	Aluminum	mg/L	1.6E+00	1.9E+00	G	1.3E+01		1.9E+00	mg/L	95% KM Approximate Gamma UCL	3
	Antimony	mg/L	NA	NA		9.0E-04	J	9.0E-04	mg/L	Maximum	5
	Arsenic	mg/L	8.6E-04	9.2E-04	N	1.0E-03		9.2E-04	mg/L	95% KM (t) UCL	2
	Barium	mg/L	7.4E-02	7.9E-02	G	1.5E-01		7.9E-02	mg/L	95% KM Approximate Gamma UCL	3
	Cadmium	mg/L	1.8E-03	1.7E-03	L	1.5E-02		1.7E-03	mg/L	KM H-UCL	1
	Chromium	mg/L	6.8E-03	2.3E-03	N	1.2E-02		2.3E-03	mg/L	95% KM (t) UCL	2
	Cobalt	mg/L	2.5E-03	2.0E-03	N	4.0E-03		2.0E-03	mg/L	95% KM (t) UCL	2
	Copper	mg/L	1.3E-02	6.3E-03	L	5.1E-02		6.3E-03	mg/L	KM H-UCL	1
	Iron	mg/L	1.3E+00	1.8E+00	L	1.1E+01		1.8E+00	mg/L	KM H-UCL	1
	Lead	mg/L	6.2E-03	6.2E-03		6.7E-02		6.2E-03	mg/L	Arithmetic Mean	7
	Manganese	mg/L	1.7E-01	2.1E-01	G	1.2E+00		2.1E-01	mg/L	95% KM Approximate Gamma UCL	3
	Mercury	mg/L	NA	NA		5.2E-04		5.2E-04	mg/L	Maximum	5
	Molybdenum	mg/L	2.3E-03	NA		3.9E-03	J	3.9E-03	mg/L	Maximum	5
	Nickel	mg/L	4.4E-03	9.5E-03	G	1.3E-02		9.5E-03	mg/L	95% GROS Approximate Gamma UCL	3
	Selenium	mg/L	4.6E-04	4.7E-04	N	5.0E-04	J	4.7E-04	mg/L	95% KM (t) UCL	2
	Silica (as SIO2)	mg/L	NA	NA		1.5E+01		1.5E+01	mg/L	Maximum	5
	Thallium	mg/L	NA	NA		8.0E-04	J	8.0E-04	mg/L	Maximum	5
	Vanadium	mg/L	1.8E-03	2.2E-03	N	2.6E-03		2.2E-03	mg/L	95% KM (t) UCL	2
	Zinc	mg/L	1.7E-01	2.5E-01		3.8E+00		2.5E-01	mg/L	95% KM (Chebyshev) UCL	4

TABLE 3.3.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:

Statistics: Maximum - Maximum detected value
Adjusted Gamma - UCL adjusted for level significance assuming gamma distribution
GROS Approximate Gamma - UCL approximation based on the regression on order statistics (ROS) method for a gamma distribution
KM (BCA) - nonparametric UCL based upon Kaplan-Meier estimates using the bias-corrected accelerated bootstrap method
KM (Chebyshev) - nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Adjusted Gamma - UCL based upon Kaplan-Meier estimates, adjusted for level significance assuming gamma distribution
KM Approximate Gamma - UCL based upon Kaplan-Meier estimates, calculated using chi-square approximation assuming gamma distribution
KM H-UCL - UCL based upon Kaplan-Meier estimates using Land's H-statistic assuming lognormal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(5) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(6) The maximum detected concentration was used as the EPC because the UCL exceeded the maximum detected concentration.
(7) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
L = log-normal distribution
LJ = result is estimated (low)
mg/L = milligram per liter
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.3.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Exposure Point Concentration in Surface Water[1]		Exposure Point Concentration in Water Vapor[2]	
		Value	Units	Value	Units
Water Vapor Sweat Lodge Elm Creek	Aluminum	7.2E-01	mg/L	1.2E-01	mg/m^3
	Antimony	2.2E-03	mg/L	3.7E-04	mg/m^3
	Arsenic	3.1E-03	mg/L	5.1E-04	mg/m^3
	Barium	7.1E-02	mg/L	1.2E-02	mg/m^3
	Cadmium	3.9E-02	mg/L	6.4E-03	mg/m^3
	Chromium	2.8E-03	mg/L	4.6E-04	mg/m^3
	Cobalt	7.8E-03	mg/L	1.3E-03	mg/m^3
	Copper	1.4E-02	mg/L	2.4E-03	mg/m^3
	Iron	9.4E-01	mg/L	1.6E-01	mg/m^3
	Lead	6.4E-02	mg/L	1.1E-02	mg/m^3
	Manganese	6.6E-01	mg/L	1.1E-01	mg/m^3
	Nickel	1.9E-02	mg/L	3.1E-03	mg/m^3
	Selenium	5.0E-04	mg/L	8.3E-05	mg/m^3
	Vanadium	2.2E-03	mg/L	3.7E-04	mg/m^3
	Zinc	6.7E+00	mg/L	1.1E+00	mg/m^3
Water Vapor Sweat Lodge Tar Creek	Aluminum	4.7E-01	mg/L	7.8E-02	mg/m^3
	Antimony	5.7E-04	mg/L	9.4E-05	mg/m^3
	Arsenic	3.4E-02	mg/L	5.6E-03	mg/m^3
	Barium	5.0E-02	mg/L	8.3E-03	mg/m^3
	Beryllium	2.8E-04	mg/L	4.6E-05	mg/m^3
	Cadmium	1.6E-02	mg/L	2.7E-03	mg/m^3
	Chromium	3.7E-03	mg/L	6.2E-04	mg/m^3
	Cobalt	3.2E-02	mg/L	5.2E-03	mg/m^3
	Copper	6.1E-03	mg/L	1.0E-03	mg/m^3
	Iron	5.1E+01	mg/L	8.5E+00	mg/m^3
	Lead	3.7E-02	mg/L	6.1E-03	mg/m^3
	Manganese	1.6E+00	mg/L	2.7E-01	mg/m^3
	Mercury	5.8E-05	mg/L	9.6E-06	mg/m^3
	Molybdenum	1.0E-02	mg/L	1.7E-03	mg/m^3
	Nickel	3.3E-01	mg/L	5.5E-02	mg/m^3
	Selenium	8.1E-04	mg/L	1.3E-04	mg/m^3
	Silica (as SIO2)	1.6E+01	mg/L	2.6E+00	mg/m^3
	Silver	2.2E-04	mg/L	3.7E-05	mg/m^3
	Thallium	2.3E-04	mg/L	3.8E-05	mg/m^3
	Vanadium	8.2E-03	mg/L	1.4E-03	mg/m^3
	Zinc	6.3E+00	mg/L	1.0E+00	mg/m^3

TABLE 3.3.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Exposure Point Concentration in Surface Water[1]		Exposure Point Concentration in Water Vapor[2]	
		Value	Units	Value	Units
Water Vapor Sweat Lodge Neosho River	Aluminum	8.7E+00	mg/L	1.5E+00	mg/m^3
	Arsenic	3.6E-03	mg/L	6.0E-04	mg/m^3
	Barium	1.6E-01	mg/L	2.6E-02	mg/m^3
	Cadmium	3.8E-04	mg/L	6.4E-05	mg/m^3
	Chromium	9.0E-03	mg/L	1.5E-03	mg/m^3
	Cobalt	4.6E-03	mg/L	7.6E-04	mg/m^3
	Copper	1.3E-02	mg/L	2.1E-03	mg/m^3
	Iron	6.9E+00	mg/L	1.2E+00	mg/m^3
	Lead	4.5E-03	mg/L	7.5E-04	mg/m^3
	Manganese	2.5E-01	mg/L	4.1E-02	mg/m^3
	Molybdenum	8.0E-04	mg/L	1.3E-04	mg/m^3
	Nickel	9.4E-03	mg/L	1.6E-03	mg/m^3
	Selenium	5.0E-04	mg/L	8.3E-05	mg/m^3
	Vanadium	5.1E-03	mg/L	8.5E-04	mg/m^3
	Zinc	7.6E-02	mg/L	1.3E-02	mg/m^3
Water Vapor Sweat Lodge Beaver Creek	Aluminum	1.4E+00	mg/L	2.3E-01	mg/m^3
	Arsenic	8.4E-03	mg/L	1.4E-03	mg/m^3
	Barium	7.5E-02	mg/L	1.2E-02	mg/m^3
	Cadmium	1.8E-03	mg/L	3.0E-04	mg/m^3
	Chromium	3.3E-03	mg/L	5.4E-04	mg/m^3
	Cobalt	7.9E-03	mg/L	1.3E-03	mg/m^3
	Copper	6.4E-03	mg/L	1.1E-03	mg/m^3
	Iron	1.8E+00	mg/L	3.0E-01	mg/m^3
	Lead	1.1E-02	mg/L	1.8E-03	mg/m^3
	Manganese	2.3E-01	mg/L	3.8E-02	mg/m^3
	Nickel	1.5E-02	mg/L	2.4E-03	mg/m^3
	Selenium	2.0E-03	mg/L	3.3E-04	mg/m^3
	Silica (as SIO2)	1.5E+01	mg/L	2.6E+00	mg/m^3
	Silver	3.4E-04	mg/L	5.6E-05	mg/m^3
	Thallium	4.1E-04	mg/L	6.8E-05	mg/m^3
	Vanadium	7.4E-03	mg/L	1.2E-03	mg/m^3
	Zinc	5.9E-01	mg/L	9.7E-02	mg/m^3

TABLE 3.3.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Exposure Point Concentration in Surface Water[1]		Exposure Point Concentration in Water Vapor[2]	
		Value	Units	Value	Units
Water Vapor Sweat Lodge Lost Creek	Aluminum	3.6E-01	mg/L	5.9E-02	mg/m^3
	Barium	7.2E-02	mg/L	1.2E-02	mg/m^3
	Cadmium	3.7E-05	mg/L	6.1E-06	mg/m^3
	Copper	5.0E-02	mg/L	8.3E-03	mg/m^3
	Iron	3.2E-01	mg/L	5.3E-02	mg/m^3
	Lead	1.2E-01	mg/L	2.0E-02	mg/m^3
	Manganese	1.2E-01	mg/L	2.0E-02	mg/m^3
	Nickel	1.8E-03	mg/L	3.0E-04	mg/m^3
	Vanadium	4.0E-04	mg/L	6.6E-05	mg/m^3
	Zinc	4.6E-02	mg/L	7.6E-03	mg/m^3
Water Vapor Sweat Lodge Lower Spring River	Aluminum	1.9E+00	mg/L	3.1E-01	mg/m^3
	Antimony	9.0E-04	mg/L	1.5E-04	mg/m^3
	Arsenic	9.2E-04	mg/L	1.5E-04	mg/m^3
	Barium	7.9E-02	mg/L	1.3E-02	mg/m^3
	Cadmium	1.7E-03	mg/L	2.8E-04	mg/m^3
	Chromium	2.3E-03	mg/L	3.8E-04	mg/m^3
	Cobalt	2.0E-03	mg/L	3.3E-04	mg/m^3
	Copper	6.3E-03	mg/L	1.0E-03	mg/m^3
	Iron	1.8E+00	mg/L	3.0E-01	mg/m^3
	Lead	6.2E-03	mg/L	1.0E-03	mg/m^3
	Manganese	2.1E-01	mg/L	3.5E-02	mg/m^3
	Mercury	5.2E-04	mg/L	8.6E-05	mg/m^3
	Molybdenum	3.9E-03	mg/L	6.5E-04	mg/m^3
	Nickel	9.5E-03	mg/L	1.6E-03	mg/m^3
	Selenium	4.7E-04	mg/L	7.8E-05	mg/m^3
	Silica (as SIO2)	1.5E+01	mg/L	2.5E+00	mg/m^3
	Thallium	8.0E-04	mg/L	1.3E-04	mg/m^3
	Vanadium	2.2E-03	mg/L	3.6E-04	mg/m^3
	Zinc	2.5E-01	mg/L	4.2E-02	mg/m^3

TABLE 3.3.RME Supplement A
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Point	Chemical of Potential Concern	Exposure Point Concentration in Surface Water[1]		Exposure Point Concentration in Water Vapor[2]	
		Value	Units	Value	Units

Notes:

(1) Selection of surface water EPCs presented on Table 3.3.RME.

(2) Water vapor

RME = Reasonable Maximum Exposure

mg/m^3 = milligrams per cubic meter

mg/L = milligram per liter

$$C_{vapor} = C_{sw} \times (MW / (R \times T \times \rho w)) \times Exp\ (18.3036 - (3816.44/ (T - 46.13))$$

** Adapted the equation in the S-B EMWP (2016).

Chemical Concentration in Surface Water (C_{sw})

Chemical Concentration in Water Vapor (C_{vapor})

Molecular Weight of Water (MW) = 18 g/mole

Ideal Gas Law Constant (R) = 0.06237 mmHg-m^3/mole-K

Temperature of Sweat Lodge (T) = 339 K

Density of Liquid Water (ρw) = 1,000 g/L

Shoshone-Bannock Exposure Scenario for Use in Risk Assessment: Traditional Subsistence Lifeways. Shoshone-Bannock Tribes Environmental Waste Management Program (S-B EMWP). February 2016.

TABLE 3.4.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Fish Tissue (Tribal Lifeway - Estimated Whole Fish Concentrations [1]) Sitewide	Aluminum	mg/kg (w)	4.2E+00	5.2E+00	L	2.1E+01	J	5.2E+00	mg/kg (w)	95% H-UCL	1
	Antimony	mg/kg (w)	2.7E-01	2.4E-01	N	3.2E-01	J	2.4E-01	mg/kg (w)	95% KM (t) UCL	2
	Arsenic	mg/kg (w)	3.7E-01	3.2E-01	G	7.2E-01		3.2E-01	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Barium	mg/kg (w)	2.1E+00	2.5E+00	G	8.6E+00		2.5E+00	mg/kg (w)	95% Approximate Gamma UCL	3
	Beryllium	mg/kg (w)	1.3E-02	1.1E-02	N	2.0E-02		1.1E-02	mg/kg (w)	95% KM (t) UCL	2
	Cadmium	mg/kg (w)	6.5E-02	6.6E-02	G	1.7E-01		6.6E-02	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Chromium	mg/kg (w)	3.8E-01	4.6E-01		1.1E+00		4.6E-01	mg/kg (w)	95% KM (Chebyshev) UCL	4
	Cobalt	mg/kg (w)	5.1E-02	4.7E-02	N	9.5E-02		4.7E-02	mg/kg (w)	95% KM (t) UCL	2
	Copper	mg/kg (w)	5.8E-01	5.6E-01	G	1.5E+00		5.6E-01	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Iron	mg/kg (w)	9.9E+00	1.1E+01		2.7E+01		1.1E+01	mg/kg (w)	95% Modified-t UCL	4
	Lead	mg/kg (w)	3.6E-01	6.1E-01		2.9E+00		3.6E-01	mg/kg (w)	Arithmetic Mean	5
	Manganese	mg/kg (w)	7.1E+00	8.3E+00	G	4.6E+01		8.3E+00	mg/kg (w)	95% Approximate Gamma UCL	3
	Mercury	mg/kg (w)	3.6E-02	4.1E-02	G	1.4E-01		4.1E-02	mg/kg (w)	95% Approximate Gamma UCL	3
	Nickel	mg/kg (w)	9.5E-02	9.2E-02		2.6E-01		9.2E-02	mg/kg (w)	95% KM (BCA) UCL	4
	Selenium	mg/kg (w)	9.6E-01	8.1E-01	G	1.7E+00		8.1E-01	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Silver	mg/kg (w)	2.5E-01	2.6E-01	N	5.9E-01		2.6E-01	mg/kg (w)	95% KM (t) UCL	2
	Thallium	mg/kg (w)	4.7E-01	3.9E-01	G	1.0E+00		3.9E-01	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Vanadium	mg/kg (w)	2.0E-01	1.8E-01		6.3E-01		1.8E-01	mg/kg (w)	95% KM (BCA) UCL	4
	Zinc	mg/kg (w)	2.6E+01	3.0E+01		1.4E+02		3.0E+01	mg/kg (w)	95% Modified-t UCL	4

TABLE 3.4.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:
[1] Eviscerated whole fish concentration was estimated based on weighted concentrations of three fish body parts (carcass, fillet, and head).

Statistics: Maximum - Maximum detected value
Approximate Gamma - UCL calculated using chi-square approximation assuming gamma distribution
H-UCL - UCL based upon Land's H-statistic assuming lognormal distribution
KM (BCA) - nonparametric UCL based upon Kaplan-Meier estimates using the bias-corrected accelerated bootstrap method
KM (Chebyshev) - nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Approximate Gamma - UCL based upon Kaplan-Meier estimates, calculated using chi-square approximation assuming gamma distribution
Modified-t - nonparametric UCL adjusted for skewness

(1) Shapiro-Wilk W/Lilliefors Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(5) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
L = log-normal distribution
mg/kg (w) = milligrams per kilogram (based on wet weight)
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.5.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Fish Tissue (General Public - Game Fish Fillet) Sitewide	Aluminum	mg/kg (w)	1.6E+00	1.4E+00	L	4.7E+00	J	1.4E+00	mg/kg (w)	KM H-UCL	1
	Antimony	mg/kg (w)	3.3E-01	2.4E-01	N	4.1E-01	J	2.4E-01	mg/kg (w)	95% KM (t) UCL	2
	Arsenic	mg/kg (w)	4.4E-01	3.0E-01	N	6.1E-01	J	3.0E-01	mg/kg (w)	95% KM (t) UCL	2
	Barium	mg/kg (w)	3.2E-01	3.3E-01	G	1.8E+00		3.3E-01	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Beryllium	mg/kg (w)	1.7E-02	1.2E-02	N	3.0E-02		1.2E-02	mg/kg (w)	95% KM (t) UCL	2
	Cadmium	mg/kg (w)	7.5E-02	3.7E-02	G	1.9E-01		3.7E-02	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Chromium	mg/kg (w)	3.5E-01	3.4E-01		1.2E+00		3.4E-01	mg/kg (w)	95% KM (Chebyshev) UCL	4
	Cobalt	mg/kg (w)	NA	NA		7.0E-02	J	7.0E-02	mg/kg (w)	Maximum	5
	Copper	mg/kg (w)	5.2E-01	5.0E-01	G	1.4E+00		5.0E-01	mg/kg (w)	95% KM Approximate Gamma UCL	3
	Iron	mg/kg (w)	3.5E+00	3.8E+00		1.8E+01		3.8E+00	mg/kg (w)	95% KM (BCA) UCL	4
	Lead	mg/kg (w)	1.0E-01	3.2E-02		9.9E-01		1.0E-01	mg/kg (w)	Arithmetic Mean	6
	Manganese	mg/kg (w)	9.3E-01	2.0E+00		1.6E+01		2.0E+00	mg/kg (w)	95% Chebyshev (Mean, Sd) UCL	4
	Mercury	mg/kg (w)	4.4E-02	5.0E-02	G	1.7E-01		5.0E-02	mg/kg (w)	95% Approximate Gamma UCL	3
	Nickel	mg/kg (w)	9.0E-02	7.6E-02	N	1.4E-01		7.6E-02	mg/kg (w)	95% KM (t) UCL	2
	Selenium	mg/kg (w)	1.0E+00	8.0E-01	N	1.5E+00		8.0E-01	mg/kg (w)	95% KM (t) UCL	2
	Silver	mg/kg (w)	1.8E-01	1.6E-01	N	2.3E-01		1.6E-01	mg/kg (w)	95% KM (t) UCL	2
	Thallium	mg/kg (w)	6.2E-01	NA		6.9E-01		6.9E-01	mg/kg (w)	Maximum	5
	Zinc	mg/kg (w)	1.0E+01	1.0E+01	L	9.5E+01		1.0E+01	mg/kg (w)	KM H-UCL	1

TABLE 3.5.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:
Statistics: Maximum - Maximum detected value
Approximate Gamma - UCL calculated using chi-square approximation assuming gamma distribution
Chebyshev (mean, Sd) - nonparametric UCL using sample mean and standard deviation based on the Chebyshev inequality
KM (BCA) - nonparametric UCL based upon Kaplan-Meier estimates using the bias-corrected accelerated bootstrap method
KM (Chebyshev) - nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Approximate Gamma - UCL based upon Kaplan-Meier estimates, calculated using chi-square approximation assuming gamma distribution
KM H-UCL - UCL based upon Kaplan-Meier estimates using Land's H-statistic assuming lognormal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(5) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(6) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
L = log-normal distribution
mg/kg (w) = milligrams per kilogram (based on wet weight)
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.6.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Shellfish Tissue Sitewide	Aluminum	mg/kg (w)	1.1E+02	1.4E+02	N	3.1E+02		1.4E+02	mg/kg (w)	95% KM (t) UCL	1
	Arsenic	mg/kg (w)	1.8E+00	5.8E+00		2.0E+01	J	5.8E+00	mg/kg (w)	95% KM (Chebyshev) UCL	3
	Barium	mg/kg (w)	5.4E+01	1.1E+02		1.0E+02		1.0E+02	mg/kg (w)	Maximum	5
	Beryllium	mg/kg (w)	2.9E-01	NA		3.8E-01		3.8E-01	mg/kg (w)	Maximum	4
	Cadmium	mg/kg (w)	4.2E-01	6.4E-01	G	1.6E+00		6.4E-01	mg/kg (w)	95% KM Adjusted Gamma UCL	2
	Chromium	mg/kg (w)	4.1E-01	5.4E-01	G	8.7E-01		5.4E-01	mg/kg (w)	95% KM Adjusted Gamma UCL	2
	Cobalt	mg/kg (w)	6.3E-02	6.8E-02	N	8.0E-02	J	6.8E-02	mg/kg (w)	95% KM (t) UCL	1
	Copper	mg/kg (w)	2.6E+00	3.1E+00	N	6.6E+00		3.1E+00	mg/kg (w)	95% KM (t) UCL	1
	Iron	mg/kg (w)	1.4E+02	1.7E+02	N	3.0E+02		1.7E+02	mg/kg (w)	95% Student's-t UCL	1
	Lead	mg/kg (w)	1.9E+00	6.0E+00		2.1E+01		1.9E+00	mg/kg (w)	Arithmetic Mean	6
	Manganese	mg/kg (w)	4.0E+02	1.2E+03		1.5E+03		1.2E+03	mg/kg (w)	97.5% Chebyshev (Mean, Sd) UCL	3
	Mercury	mg/kg (w)	8.9E-03	1.2E-02	N	1.8E-02		1.2E-02	mg/kg (w)	95% Student's-t UCL	1
	Nickel	mg/kg (w)	3.2E-01	3.9E-01	N	6.1E-01		3.9E-01	mg/kg (w)	95% KM (t) UCL	1
	Selenium	mg/kg (w)	2.9E+00	8.7E+00		3.3E+01		8.7E+00	mg/kg (w)	95% KM (Chebyshev) UCL	3
	Silica (as SIO2)	mg/kg (w)	5.3E+02	6.3E+02	N	7.8E+02		6.3E+02	mg/kg (w)	95% Student's-t UCL	1
	Silver	mg/kg (w)	6.0E-01	8.2E-01	L	7.2E-01		7.2E-01	mg/kg (w)	Maximum	5
	Zinc	mg/kg (w)	2.0E+02	4.6E+02		1.1E+03		4.6E+02	mg/kg (w)	95% Chebyshev (Mean, Sd) UCL	3

TABLE 3.6.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:
Statistics: Maximum - Maximum detected value
Chebyshev (mean, Sd) - nonparametric UCL using sample mean and standard deviation based on the Chebyshev inequality
KM (Chebyshev) - nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Adjusted Gamma - UCL based upon Kaplan-Meier estimates, adjusted for level significance assuming gamma distribution
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(2) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(3) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(4) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(5) The maximum detected concentration was used as the EPC because the UCL exceeded the maximum detected concentration.
(6) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
mg/kg (w) = milligrams per kilogram (based on wet weight)
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.7.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Aquatic Plants as Food (Arrowhead and Duckweed) Sitewide	Aluminum	mg/kg (w)	2.7E+02	3.9E+02	N	7.9E+02		3.9E+02	mg/kg (w)	95% Student's-t UCL	2
	Antimony	mg/kg (w)	3.8E-01	NA		3.8E-01	J	3.8E-01	mg/kg (w)	Maximum	5
	Arsenic	mg/kg (w)	1.4E+00	1.5E+00	L	9.1E+00		1.5E+00	mg/kg (w)	KM H-UCL	1
	Barium	mg/kg (w)	1.6E+01	2.1E+01	N	3.2E+01		2.1E+01	mg/kg (w)	95% Student's-t UCL	2
	Beryllium	mg/kg (w)	4.7E-02	4.1E-02	N	7.0E-02		4.1E-02	mg/kg (w)	95% KM (t) UCL	2
	Cadmium	mg/kg (w)	2.4E+00	1.5E+01		2.1E+01		1.5E+01	mg/kg (w)	99% Chebyshev (Mean, Sd) UCL	4
	Chromium	mg/kg (w)	1.0E+00	2.7E+00		4.3E+00		2.7E+00	mg/kg (w)	95% KM Bootstrap t UCL	4
	Cobalt	mg/kg (w)	1.6E+00	3.7E+00	G	7.9E+00		3.7E+00	mg/kg (w)	95% Adjusted Gamma UCL	3
	Copper	mg/kg (w)	4.3E+00	1.9E+01		2.3E+01		1.9E+01	mg/kg (w)	95% KM Bootstrap t UCL	4
	Iron	mg/kg (w)	2.4E+03	6.1E+03	G	1.2E+04		6.1E+03	mg/kg (w)	95% Adjusted Gamma UCL	3
	Lead	mg/kg (w)	7.1E+01	5.8E+02		8.4E+02	J	7.1E+01	mg/kg (w)	Arithmetic Mean	6
	Manganese	mg/kg (w)	2.0E+02	3.0E+02	N	5.7E+02		3.0E+02	mg/kg (w)	95% Student's-t UCL	2
	Mercury	mg/kg (w)	1.2E-02	4.5E-02		9.4E-02		4.5E-02	mg/kg (w)	95% Chebyshev (Mean, Sd) UCL	4
	Nickel	mg/kg (w)	1.2E+00	1.7E+00	N	3.6E+00		1.7E+00	mg/kg (w)	95% Student's-t UCL	2
	Silver	mg/kg (w)	NA	NA		1.7E-01		1.7E-01	mg/kg (w)	Maximum	5
	Vanadium	mg/kg (w)	1.4E+00	2.5E+00	G	5.1E+00		2.5E+00	mg/kg (w)	95% Adjusted Gamma UCL	3
	Zinc	mg/kg (w)	2.8E+02	1.4E+03		1.8E+03		1.4E+03	mg/kg (w)	99% Chebyshev (Mean, Sd) UCL	4

TABLE 3.7.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:
Statistics: Maximum - Maximum detected value
Adjusted Gamma - UCL adjusted for level significance assuming gamma distribution
Chebyshev (mean, Sd) - nonparametric UCL using sample mean and standard deviation based on the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Bootstrap t - nonparametric UCL based upon Kaplan-Meier estimates using the bootstrap-t method
KM H-UCL - UCL based upon Kaplan-Meier estimates using Land's H-statistic assuming lognormal distribution
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(5) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(6) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
L = log-normal distribution
mg/kg (w) = milligrams per kilogram (based on wet weight)
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.8.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Aquatic Plants as Salve (Arrowhead) Sitewide	Aluminum	mg/kg (w)	2.9E+02	4.5E+02	N	7.9E+02		4.5E+02	mg/kg (w)	95% Student's-t UCL	1
	Antimony	mg/kg (w)	3.8E-01	NA		3.8E-01	J	3.8E-01	mg/kg (w)	Maximum	4
	Arsenic	mg/kg (w)	1.8E+00	1.0E+01		9.1E+00		9.1E+00	mg/kg (w)	Maximum	6
	Barium	mg/kg (w)	1.4E+01	2.0E+01	N	3.1E+01		2.0E+01	mg/kg (w)	95% Student's-t UCL	1
	Beryllium	mg/kg (w)	4.0E-02	3.8E-02	N	6.0E-02		3.8E-02	mg/kg (w)	95% KM (t) UCL	1
	Cadmium	mg/kg (w)	2.9E+00	2.2E+01		2.1E+01		2.1E+01	mg/kg (w)	Maximum	6
	Chromium	mg/kg (w)	1.1E+00	3.7E+00		4.3E+00		3.7E+00	mg/kg (w)	95% KM Bootstrap t UCL	3
	Cobalt	mg/kg (w)	1.8E+00	6.2E+00	G	7.9E+00		6.2E+00	mg/kg (w)	95% Adjusted Gamma UCL	2
	Copper	mg/kg (w)	4.9E+00	3.9E+01		2.3E+01		2.3E+01	mg/kg (w)	Maximum	6
	Iron	mg/kg (w)	3.1E+03	5.6E+03	N	1.2E+04		5.6E+03	mg/kg (w)	95% Student's-t UCL	1
	Lead	mg/kg (w)	1.1E+02	8.8E+02		8.4E+02	J	1.1E+02	mg/kg (w)	Arithmetic Mean	5
	Manganese	mg/kg (w)	1.6E+02	4.2E+02	G	5.3E+02		4.2E+02	mg/kg (w)	95% Adjusted Gamma UCL	2
	Mercury	mg/kg (w)	1.4E-02	3.1E-01		9.4E-02		9.4E-02	mg/kg (w)	Maximum	6
	Nickel	mg/kg (w)	1.2E+00	1.9E+00	N	3.6E+00		1.9E+00	mg/kg (w)	95% Student's-t UCL	1
	Vanadium	mg/kg (w)	1.5E+00	2.5E+00	N	5.1E+00		2.5E+00	mg/kg (w)	95% Student's-t UCL	1
	Zinc	mg/kg (w)	3.1E+02	2.0E+03		1.8E+03		1.8E+03	mg/kg (w)	Maximum	6

TABLE 3.8.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:
Statistics: Maximum - Maximum detected value
Adjusted Gamma - UCL adjusted for level significance assuming gamma distribution
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Bootstrap t - nonparametric UCL based upon Kaplan-Meier estimates using the bootstrap-t method
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(2) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(3) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(4) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(5) The arithmetic mean concentration was used as the EPC for lead.
(6) The maximum detected concentration was used as the EPC because the UCL exceeded the maximum detected concentration.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
mg/kg (w) = milligrams per kilogram (based on wet weight)
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.9.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Amphibian/Aquatic Reptile Tissue (Frog Legs) Sitewide	Aluminum	mg/kg (w)	4.0E+00	4.3E+00	N	1.0E+01	J	4.3E+00	mg/kg (w)	95% KM (t) UCL	1
	Arsenic	mg/kg (w)	3.9E-01	NA		5.5E-01	J	5.5E-01	mg/kg (w)	Maximum	3
	Barium	mg/kg (w)	3.8E+00	4.5E+00	N	5.7E+00		4.5E+00	mg/kg (w)	95% Student's-t UCL	1
	Beryllium	mg/kg (w)	1.5E-02	NA		2.0E-02		2.0E-02	mg/kg (w)	Maximum	3
	Cadmium	mg/kg (w)	5.6E-02	5.9E-02	N	1.0E-01		5.9E-02	mg/kg (w)	95% KM (t) UCL	1
	Chromium	mg/kg (w)	4.8E-01	4.6E-01	N	1.1E+00		4.6E-01	mg/kg (w)	95% KM (t) UCL	1
	Copper	mg/kg (w)	6.1E-01	5.8E-01	N	1.2E+00		5.8E-01	mg/kg (w)	95% KM (t) UCL	1
	Iron	mg/kg (w)	6.4E+00	8.2E+00	G	1.3E+01		8.2E+00	mg/kg (w)	95% Adjusted Gamma UCL	2
	Lead	mg/kg (w)	4.8E-01	7.3E-01	L	1.9E+00		4.8E-01	mg/kg (w)	Arithmetic Mean	4
	Manganese	mg/kg (w)	3.2E+00	4.0E+00	N	7.1E+00		4.0E+00	mg/kg (w)	95% Student's-t UCL	1
	Mercury	mg/kg (w)	1.5E-02	1.7E-02	N	2.4E-02		1.7E-02	mg/kg (w)	95% Student's-t UCL	1
	Nickel	mg/kg (w)	1.2E-01	NA		1.3E-01		1.3E-01	mg/kg (w)	Maximum	3
	Selenium	mg/kg (w)	NA	NA		8.3E-01	J	8.3E-01	mg/kg (w)	Maximum	3
	Silver	mg/kg (w)	2.3E-01	2.0E-01	N	3.5E-01		2.0E-01	mg/kg (w)	95% KM (t) UCL	1
	Thallium	mg/kg (w)	5.4E-01	NA		5.7E-01	J	5.7E-01	mg/kg (w)	Maximum	3
	Zinc	mg/kg (w)	2.0E+01	2.7E+01	G	4.2E+01		2.7E+01	mg/kg (w)	95% Adjusted Gamma UCL	2

TABLE 3.9.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:
Statistics: Maximum - Maximum detected value
Adjusted Gamma - UCL adjusted for level significance assuming gamma distribution
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(2) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(3) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(4) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
L = log-normal distribution
mg/kg (w) = milligrams per kilogram (based on wet weight)
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 3.10.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)		Maximum Concentration (Qualifier)		Exposure Point Concentration			
								Value	Units	Statistic	Rationale
Semi-Aquatic Mammals Tissue (Raccoon) Sitewide	Aluminum	mg/kg (w)	3.1E+00	4.9E+00	G	1.4E+01		4.9E+00	mg/kg (w)	95% GROS Adjusted Gamma UCL	3
	Antimony	mg/kg (w)	NA	NA		3.1E-01	J	3.1E-01	mg/kg (w)	Maximum	5
	Arsenic	mg/kg (w)	NA	NA		3.9E-01	J	3.9E-01	mg/kg (w)	Maximum	5
	Barium	mg/kg (w)	6.6E-02	1.1E-01		2.4E-01		1.1E-01	mg/kg (w)	95% KM (Chebyshev) UCL	4
	Beryllium	mg/kg (w)	NA	NA		4.0E-02		4.0E-02	mg/kg (w)	Maximum	5
	Cadmium	mg/kg (w)	5.3E-02	4.7E-02	N	9.0E-02		4.7E-02	mg/kg (w)	95% KM (t) UCL	2
	Chromium	mg/kg (w)	1.9E-01	3.2E-01		8.8E-01		3.2E-01	mg/kg (w)	95% KM (Chebyshev) UCL	4
	Copper	mg/kg (w)	1.4E+00	1.5E+00	N	2.2E+00		1.5E+00	mg/kg (w)	95% KM (t) UCL	2
	Iron	mg/kg (w)	3.3E+01	3.8E+01	N	6.6E+01		3.8E+01	mg/kg (w)	95% Student's-t UCL	2
	Lead	mg/kg (w)	5.1E-01	NA		5.2E+00		5.1E-01	mg/kg (w)	Arithmetic Mean	6
	Manganese	mg/kg (w)	3.1E-01	3.4E-01	L	1.4E+00		3.4E-01	mg/kg (w)	KM H-UCL	1
	Mercury	mg/kg (w)	4.4E-02	5.8E-02	N	1.4E-01		5.8E-02	mg/kg (w)	95% Student's-t UCL	2
	Nickel	mg/kg (w)	NA	NA		3.7E-01		3.7E-01	mg/kg (w)	Maximum	5
	Selenium	mg/kg (w)	8.5E-01	7.8E-01	N	9.3E-01	J	7.8E-01	mg/kg (w)	95% KM (t) UCL	2
	Thallium	mg/kg (w)	4.1E-01	NA		4.6E-01	J	4.6E-01	mg/kg (w)	Maximum	5
	Zinc	mg/kg (w)	4.3E+01	4.6E+01	N	6.1E+01		4.6E+01	mg/kg (w)	95% Student's-t UCL	2

TABLE 3.10.RME
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale

Notes:
Statistics: Maximum - Maximum detected value
GROS Adjusted Gamma - UCL based on the regression on order statistics (ROS) method, adjusted for level significance assuming gamma distribution
KM (Chebyshev) - nonparametric UCL based upon Kaplan-Meier estimates using the Chebyshev inequality
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM H-UCL - UCL based upon Kaplan-Meier estimates using Land's H-statistic assuming lognormal distribution
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are log-normally distributed.
(2) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(3) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(4) Distribution tests are inconclusive; therefore, the nonparametric UCL was used as the EPC.
(5) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(6) The arithmetic mean concentration was used as the EPC for lead.

EPC = Exposure Point Concentration
G = gamma distribution
J = result is estimated
L = log-normal distribution
mg/kg (w) = milligrams per kilogram (based on wet weight)
N = normal distribution
NA = not available
RME = Reasonable Maximum Exposure
UCL = Upper Confidence Limit

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Tribal Lifeway	Adult	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-Sed	Ingestion Rate of Sediment (1)	400	mg/day	Harper, 2008	C_{sed} x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	312	days/year	(9)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(2)	
		Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-Sed	Ingestion Rate of Sediment	400	mg/day	Harper, 2008	C_{sed} x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	312	days/year	(4, 9)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(2)	
		Adult/Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-Sed-Adj	Ingestion Rate of Sediment, Age-adjusted	164,023	mg/kg	Calculated	C_{Sed} x IR-Sed-Adj x CF1 x 1/AT
				AT-C	Averaging Time (Cancer)	25,550	days	(3)	IR-Sed-Adj (mg/kg) =
									(ED-C x EF-C x IR-S-C / BW-C) + (ED-A x EF-A x IR-S-A / BW-A)
	Aquatic Workers	Adult	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) =
				IR-Sed	Ingestion Rate of Sediment	400	mg/day	Harper, 2008	C_{sed} x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	250	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(2)	
				AT-C	Averaging Time (Cancer)	25,550	days	(3)	
	General Public (Recreator) Wading	Adult	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-Sed	Ingestion Rate of Sediment	100	mg/day	EPA, 1991	C_{sed} x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	28	days/year	(5)	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	(2)	
		Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-Sed	Ingestion Rate of Sediment	200	mg/day	EPA, 1991	C_{sed} x IR-Sed x EF x ED x CF1 x 1/BW x 1/AT
				EF	Exposure Frequency	28	days/year	(5)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(2)	
		Adult/Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-Sed-Adj	Adjusted Ingestion Rate of Sediment	2,940	mg/kg	Calculated	C_{Sed} x IR-Sed-Adj x CF1 x 1/AT
				AT-C	Averaging Time (Cancer)	25,550	days	(3)	IR-Sed-Adj (mg/kg) =
				CF1	Conversion Factor 1	0.000001	kg/mg		(ED-C x EF-C x IR-S-C / BW-C) + (ED-A x EF-A x IR-S-A / BW-A)

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Tribal Lifeway	Adult	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	19,652	cm^2	EPA, 2014 (6)	C_{sed} x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SSAF	Soil to Skin Adherence Factor	0.1	mg/cm^2-day	Harper, 2008	
				DABS	Dermal Absorption Factor Solids	Chemical-specific	--	EPA, 2004	
				EF	Exposure Frequency	312	days/year	(9)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(2)	
		Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	6,365	cm^2	EPA, 2014 (6)	C_{sed} x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SSAF	Soil to Skin Adherence Factor	0.1	mg/cm^2-day	Harper, 2008	
				DABS	Dermal Absorption Factor Solids	Chemical-specific	--	EPA, 2004	
				EF	Exposure Frequency	312	days/year	(4, 9)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(2)	
		Adult/Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	640,023	mg/kg	Calculated	C_{Sed} x DA-Adj x DABS x CF1 x 1/AT
				AT-C	Averaging Time (Cancer)	25,550	days	(3)	DA-Adj (mg/kg) =
									(ED-C x EF-C x SA-C x SSAF-C / BW-C) + (ED-A x EF-A x SA-A x SSAF-A / BW-A)
	Aquatic Workers	Adult	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	19,652	cm^2	EPA, 2014 (6)	C_{sed} x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SSAF	Soil to Skin Adherence Factor	0.1	mg/cm^2-day	Harper, 2008	
				DABS	Dermal Absorption Factor Solids	Chemical-specific	--	EPA, 2004	
				EF	Exposure Frequency	250	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(2)	
				AT-C	Averaging Time (Cancer)	25,550	days	(3)	
	General Public (Recreator) Wading	Adult	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	6,032	cm^2	EPA, 2014 (7)	C_{sed} x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SSAF	Soil to Skin Adherence Factor	0.07	mg/cm^2-day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical-specific	--	EPA, 2004	
				EF	Exposure Frequency	28	days/year	(5)	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	(2)	

TABLE 4.1.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment (Rivers and Creeks)
Exposure Medium: Sediment (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	General Public (Recreator) Wading (cont'd)	Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,373	cm^2	EPA, 2014 (8)	C_{sed} x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	EPA, 2004	
				DABS	Dermal Absorption Factor Solids	Chemical-specific	--	EPA, 2004	
				EF	Exposure Frequency	28	days/year	(5)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(2)	
		Adult/Child	Sediment (0 to 12-inch deep)	C_{sed}	Chemical Concentration in Sediment	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				DA-Adj	Dermal Absorption, Age-adjusted	8,271	mg/kg	Calculated	C_{Sed} x DA-Adj x DABS x CF1 x 1/AT
				AT-C	Averaging Time for Carcinogenic Effects	25,550	days	(3)	DA-Adj (mg/kg) =
				CF1	Conversion Factor 1	0	kg/mg	–	(ED-C x EF-C x SA-C x SSAF-C / BW-C) + (ED-A x EF-A x SA-A x SSAF-A / BW-A)

Notes:

(1) Relative bioavailability factor (RBA) of 0.6 used to calculate ingestion intake from sediment for arsenic.
(2) Calculated as the product of ED (years) x 365 days/year.
(3) Calculated as the product of 70 years assumed human lifetime x 365 days/year.
(4) Higher exposure frequency than surface water due to contact with sediment-laden items.
(5) Assumes 1 day/week for the months April - October but no exposures November - March.
(6) Total skin area.
(7) SA includes head, hands, forearms, lower legs.
(8) SA includes head, hands, forearms, lower legs, and feet.
(9) Professional judgement based on input from TCTCIT.

Sources:

EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July.
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Tar Creek Trustee Council Indian Tribes (TCTCIT). 2018. Responses to Draft Risk Assessment Guidance forSuperfund (RAGS) Part D Tables 1 through 6 provided for review on November 14, 2017.

TABLE 4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Tribal Lifeway	Adult	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) =
			(Rivers and Creeks)	IR-SW	Ingestion Rate of Water (swimming/wading)	0.092	L/hr	EPA, 2019a	C_{SW} x IR-SW x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time (swimming/wading)	6	hr/day	(3, 8)	
				EF	Exposure Frequency	312	days/year	(8)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
			(Rivers and Creeks)	IR-SW	Ingestion Rate of Water (swimming/wading)	0.12	L/hr	EPA, 2011	C_{SW} x IR-SW x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time (swimming/wading)	6	hr/day	(3, 8)	
				EF	Exposure Frequency	234	days/year	(8)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = C_{SW} x IR-SW-Adj x 1/AT
			(Rivers and Creeks)	IR-SW_Adj	Ingestion Rate of Water (swimming/wading)	224.9	L/kg	Calculated	IR-SW-Adj (L/kg) =
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	(ED-C x ET-C x EF-C x IR-SW-C / BW-C) + (ED-A x ET-A x EF-A x IR-SW-A / BW-A)
	Aquatic Worker	Adult	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) =
			(Rivers and Creeks)	IR-SW	Ingestion Rate of Water (swimming)	0.092	liters/hr	EPA, 2019a	C_{SW} x IR-SW x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time (swimming)	6	hr/day	(3, 8)	
				EF	Exposure Frequency	250	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
	General Public (Recreator)	Adult	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) =
			(Rivers and Creeks)	IR-SW	Ingestion Rate of Water (swimming)	0.092	L/hr	EPA, 2019a	C_{SW} x IR-SW x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time (swimming)	1	hr/day	(4)	
				EF	Exposure Frequency	28	days/year	(4)	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	(1)	
		Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
			(Rivers and Creeks)	IR-SW	Ingestion Rate of Water (swimming)	0.12	L/hr	EPA, 2011	C_{SW} x IR-SW x ET x EF x ED x 1/BW x 1/AT
				ET	Exposure Time (swimming)	1	hr/day	(4)	
				EF	Exposure Frequency	28	days/year	(4)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	µg/L	Calculated	CDI (mg/kg-day) = C_{SW} x IR-SW-Adj x 1/AT
			(Rivers and Creeks)	IR-SW_Adj	Ingestion Rate of Water (swimming)	1.99	L/kg	Calculated	IR-SW-Adj (L/kg) =
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	(ED-C x ET-C x EF-C x IR-SW-C / BW-C) + (ED-A x ET-A x EF-A x IR-SW-A / BW-A)

TABLE 4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Tribal Lifeway	Adult	Surface Water (Rivers and Creeks)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				DA_{event}	Dermally Absorbed Dose per Event	calculated	mg/cm^2-event	Calculated	
				t_{event}	Event Time (swimming/wading)	6	hr/event	(3, 8)	
				SA	Skin Surface Area Available for Contact (swimming/wading)	19,652	cm^2	EPA, 2014 (5)	
				EV	Event Frequency	1	events/day	(8)	
				EF	Exposure Frequency	312	days/year	(8)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Surface Water (Rivers and Creeks)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	
				t_{event}	Event Time (swimming/wading)	6	hr/event	(3, 8)	
				SA	Skin Surface Area Available for Contact (swimming/wading)	6,365	cm^2	EPA, 2014 (5)	
				EV	Event Frequency	1	events/day	(8)	
				EF	Exposure Frequency	234	days/year	(8)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Surface Water (Rivers and Creeks)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = DA_{event}-Adj x 1/AT
				DA_{event}-Adj	Dermally Absorbed Dose, Age-adjusted (swimming/wading)	Calculated	mg/kg	Calculated	DA_{event}-Adj = (DA_{event}-A x SA-A x ED-A x EF-A x EV-A x 1/BW-A)
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
	Aquatic Worker	Adult	Surface Water (Rivers and Creeks)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	
				t_{event}	Event Time	6	hr/event	(3, 8)	
				SA	Skin Surface Area Available for Contact	19,652	cm^2	EPA, 2014 (5)	
				EV	Event Frequency	1	events/day	(4)	
				EF	Exposure Frequency	250	days/year	EPA, 2014	
				ED	Exposure Duration	25	years	EPA, 2014	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	9,125	days	(1)	
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
	General Public (Recreator)	Adult	Surface Water (Rivers and Creeks)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	
				t_{event}	Event Time (swimming)	1	hr/event	(4)	
				t_{event}	Event Time (wading)	2	hr/event	(4)	
				SA	Skin Surface Area Available for Contact (swimming)	19,652	cm^2	EPA, 2014 (5)	
				SA	Skin Surface Area Available for Contact (wading)	6,032	cm^2	EPA, 2014 (6)	
				EV	Event Frequency	1	events/day	(4)	
				EF	Exposure Frequency	28	days/year	(4)	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	(1)	

TABLE 4.2.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	General Public (Recreator) (cont'd)	Child	Surface Water (Rivers and Creeks)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				t_{event}	Event Time (swimming)	1	hr/event	(4)	
				t_{event}	Event Time (wading)	2	hr/event	(4)	
				SA	Skin Surface Area Available for Contact (swimming)	6,365	cm^2	EPA, 2014 (5)	
				SA	Skin Surface Area Available for Contact (wading)	2,373	cm^2	EPA, 2014 (7)	
				EV	Event Frequency	1	events/day	(4)	
				EF	Exposure Frequency	28	days/year	(4)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Surface Water (Rivers and Creeks)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				DA_{event}-Adj	Dermally Absorbed Dose, Age-adjusted (swimming)	Calculated	mg/kg	Calculated	DA_{event}-Adj x 1/AT
				DA_{event}-Adj	Dermally Absorbed Dose, Age-adjusted (wading)	Calculated	mg/kg	Calculated	DA_{event}-Adj =
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	(DA_{event}-A x SA-A x ED-A x EF-A x EV-A x 1/BW-A)
				Kp	Permeability Coefficient	Chemical-specific	cm/hr	2019b	+ (DA_{event}-C x SA-C x ED-C x EF-C x EV-C x 1/BW-C)
				CF2	Conversion Factor 2	0.001	L/cm^3	--	DA_{event} (mg/cm^2-event) =
									Kp x C_{SW} x t_{event} x CF2

Notes:

(1) Calculated as the product of ED (years) x 365 days/year.
(2) Calculated as the product of 70 years assumed human lifetime x 365 days/year.
(3) TCTCIT indicated a total of 6 hours of water contact for working and outside of work combined.
(4) Assumes 2 hours/event and 1 event/week for the months April - October but no exposures November - March.
(5) Total skin area.
(6) SA includes head, hands, forearms, lower legs.
(7) SA includes head, hands, forearms, lower legs, and feet.
(8) Professional judgement based on input from TCTCIT.

Sources:

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TABLE 4.3.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Tribal Lifeway	Adult	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) =
			(Potable Use)	IR-SW	Ingestion Rate of Water	2.5	L/day	EPA, 2014	C_{SW} x IR-SW x EF x ED x 1/BW x 1/AT
				EF	Exposure Frequency	365	days/year	Harper et al., 2002	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
			(Potable Use)	IR-SW	Ingestion Rate of Surface Water	0.78	L/day	EPA, 2014	C_{SW} x IR-SW x EF x ED x 1/BW x 1/AT
				EF	Exposure Frequency	365	days/year	Harper et al., 2002	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
			(Potable Use)	IR-SW-Adj	Ingestion Rate of Water, Age-adjusted	948.2	L/kg	Calculated	C_{SW} x IR-SW-Adj x 1/AT
				AT-C	Averaging Time (Cancer)	25,550	days	Harper et al., 2002	IR-SW-Adj (L/kg) =
									(ED-C x EF-C x IR-SW-C / BW-C) + (ED-A x EF-A x IR-SW-A / BW-A)
	General Public	Adult	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
			(Potable Use)	IR-SW	Ingestion Rate of Water	2.5	L/day	EPA, 2014	C_{SW} x IR-SW x EF x ED x 1/BW x 1/AT
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	(1)	
		Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
			(Potable Use)	IR-SW	Ingestion Rate of Surface Water	0.78	L/day	EPA, 2014	C_{SW} x IR-SW x EF x ED x 1/BW x 1/AT
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Surface Water	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
			(Potable Use)	IR-SW-Adj	Ingestion Rate of Water, Age-adjusted	328.0	L/kg	Calculated	C_{SW} x IR-SW-Adj x 1/AT
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	IR-SW-Adj (L/kg) =
									(ED-C x EF-C x IR-SW-C / BW-C) + (ED-A x EF-A x IR-SW-A / BW-A)

TABLE 4.3.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Tribal Lifeway	Adult	Surface Water (Potable Use)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				t_{event}	Event Time	0.71	hr/event	EPA, 2014	
				SA	Skin Surface Area Available for Contact	19,652	cm^2	EPA, 2014 (3)	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	365	days/year	Harper et al., 2002	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Surface Water (Potable Use)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				t_{event}	Event Time	0.54	hr/event	EPA, 2014	
				SA	Skin Surface Area Available for Contact	6,365	cm^2	EPA, 2014 (3)	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	365	days/year	Harper et al., 2002	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Surface Water (Potable Use)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				DA_{event}-Adj	Dermally Absorbed Dose, Age-adjusted	Calculated	mg/kg	Calculated	DA_{event}-Adj x 1/AT
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	DA_{event}-Adj =
									(DA_{event}-A x SA-A x ED-A x EF-A x EV-A x 1/BW-A)
									+ (DA_{event}-C x SA-C x ED-C x EF-C x EV-C x 1/BW-C)
	General Public	Adult	Surface Water (Potable Use)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				t_{event}	Event Time	0.71	hr/event	EPA, 2014	
				SA	Skin Surface Area Available for Contact	19,652	cm^2	EPA, 2014 (3)	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	(1)	
		Child	Surface Water (Potable Use)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				DA_{event}	Dermally Absorbed Dose per Event	Calculated	mg/cm^2-event	Calculated	DA_{event} x SA x EV x EF x ED x 1/BW x 1/AT
				t_{event}	Event Time	0.54	hr/event	EPA, 2014	
				SA	Skin Surface Area Available for Contact	6,365	cm^2	EPA, 2014 (3)	
				EV	Event Frequency	1	events/day	EPA, 2004	
				EF	Exposure Frequency	350	days/year	EPA, 2014	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	

TABLE 4.3.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	General Public (cont'd)	Adult/Child	Surface Water (Potable Use)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = DA_{event}-Adj x 1/AT
				DA_{event}-Adj	Dermally Absorbed Dose, Age-adjusted	Calculated	mg/kg	Calculated	DA_{event}-Adj = (DA_{event}-A x SA-A x ED-A x EF-A x EV-A x 1/BW-A) + (DA_{event}-C x SA-C x ED-C x EF-C x EV-C x 1/BW-C)
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
				Kp	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	DA_{event} (mg/cm^2-event) = Kp x C_{SW} x t_{event} x CF2
				CF2	Conversion Factor 2	0.001	L/cm^3	--	

Notes:

(1) Calculated as the product of ED (years) x 365 days/year.

(2) Calculated as the product of 70 years assumed human lifetime x 365 days/year.

(3) Total skin area.

Sources:

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TABLE 4.4.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Tribal Lifeway	Adult	Surface Water (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) = C_{sw} x IR-SW x EF x ED x 1/BW x 1/AT
				IR-SW	Ingestion Rate of Water	1	L/day	Harper, 2008	
				EF	Exposure Frequency	365	days/year	(7)	
				ED	Exposure Duration	64	years	Quapaw comment	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Surface Water (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = C_{sw} x IR-SW x EF x ED x 1/BW x 1/AT
				IR-SW	Ingestion Rate of Surface Water	1	L/day	(3)	
				EF	Exposure Frequency	365	days/year	(7)	
				ED	Exposure Duration	4	years	Quapaw comment (4)	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	1,460	days	(1)	
		Adult/Child	Surface Water (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = C_{sw} x IR-SW-Adj x 1/AT
				IR-SW-Adj	Ingestion Rate of Surface Water, Age-adjusted	431.05	L/kg	Calculated	IR-SW-Adj (L/kg) = (ED-C x EF-C x IR-SW-C / BW-C) + (ED-A x EF-A x IR-SW-A / BW-A)
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
Dermal	Tribal Lifeway	Adult	Surface Water (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = C_{vapor} x SA x f_{SA} x Kp x ET x EF x ED x CF3 x 1/BW x 1/AT
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	
				SA	Skin Surface Area Available for Contact	19,652	cm^2	EPA, 2014 (5)	** Adapted the equation in the S-B EMWP (2016).
				f_{SA}	Fraction of Skin Area	1	unitless	(6)	
				Kp	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	
				ET	Event Time	1	hr/day	(7)	
				EF	Exposure Frequency	365	days/year	(7)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Surface Water (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) = C_{vapor} x SA x f_{SA} x Kp x ET x EF x ED x CF3 x 1/BW x 1/AT
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	
				SA	Skin Surface Area Available for Contact	6,365	cm^2	EPA, 2014 (5)	** Adapted the equation in the S-B EMWP (2016).
				f_{SA}	Fraction of Skin Area	1	unitless	(6)	
				Kp	Permeability Coefficient	Chemical-specific	cm/hr	EPA, 2004	
				ET	Event Time	1	hr/day	(7)	
				EF	Exposure Frequency	365	days/year	(7)	
				ED	Exposure Duration	4	years	Quapaw comment (4)	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	1,460	days	(1)	

TABLE 4.4.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water (Rivers and Creeks)
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal (cont'd)	Tribal Lifeway (cont'd)	Adult/Child	Surface Water (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	CDI (mg/kg-day) =
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	DA-Adj x 1/AT
				DA-Adj	Dermally Absorbed Dose, Age-adjusted	Calculated	mg/kg	Calculated	DA-Adj =
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	C_{vapor} x f_{SA} x Kp x CF3 x
				C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	((SA-A x ET-A x EF-A x ED-A x 1/BW-A) + (SA-C x ET-C x EF-C x ED-C x 1/BW-C))
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	
				MW	Molecular Weight of Water	18	g/mole	- -	C_{vapor} =
				R	Ideal gas Law constant	0.06237	$mmHg-m^3/(mole-K$	- -	C_{sw} x ((MW / (R x T x ρw)) x Exp (18.3036 - (3816.44/ (T - 46.13)))
				T	Temperature of Sweat Lodge	339	K	- -	** Adapted the equation in the S-B EMWP (2016).
				ρw	Density of Liquid Water	1,000	g/L	- -	
				CF3	Conversion Factor 3	0.000001	m^3/cm^3	--	

Notes:

(1) Calculated as the product of ED (years) x 365 days/year.
(2) Calculated as the product of 70 years assumed human lifetime (Harper, 2007) x 365 days/year.
(3) The same as the values identified for adult.
(4) Children ages 2-6.
(5) Total skin area.
(6) Conservatively assumed that 100% of skin surface area comes in contact with water vapor.
(7) EF (365 days/year) and ET (1 hour/day) based on Shoshane-Bannock, 2016. These exposure assumptions are more conservative than input provided by Quapaw and TCTCIT.

Sources:

EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July.
EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6.
Harper, 2007. Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Report of Grant Number EPA-STAR-J1-R831046. August.
Harper, 2008. Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc.
Tar Creek Trustee Council Indian Tribes (TCTCIT). 2018. Responses to Draft Risk Assessment Guidance forSuperfund (RAGS) Part D Tables 1 through 6 provided for review on November 14, 2017.
Shoshone-Bannock Exposure Scenario for Use in Risk Assessment: Traditional Subsistence Lifeways. Shoshone-Bannock Tribes Environmental Waste Management Program (S-B EMWP). February 2016.

TABLE 4.5.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water (Rivers and Creeks)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Tribal Lifeway	Adult	Water Vapor (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	Exposure Concentration (EC) (mg/m^3) =
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	C_{vapor} x ET x EF x ED x CF4 x 1/AT
				ET	Event Time	1	hr/day	(4)	
				EF	Exposure Frequency	365	days/year	(4)	
				ED	Exposure Duration	64	years	Quapaw comment	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Water Vapor (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	EC (mg/m^3) =
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	C_{vapor} x ET x EF x ED x CF4 x 1/AT
				ET	Event Time	1	hr/day	(4)	
				EF	Exposure Frequency	365	days/year	(4)	
				ED	Exposure Duration	4	years	Quapaw comment (3)	
				AT-N	Averaging Time (Non-Cancer)	1,460	days	(1)	
		Adult/Child	Water Vapor (Sweat Lodge)	C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	EC (mg/m^3) =
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	C_{vapor} x ((ET-C x EF-C x ED-C) + (ET-A x EF-A x ED-A)) x CF4 x 1/AT
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
				C_{sw}	Chemical Concentration in Surface Water	EPC	mg/L	Calculated	C_{vapor} =
				C_{vapor}	Chemical Concentration in Water Vapor	EPC	mg/m^3	Calculated	C_{sw} x ((MW / (R x T x ρw)) x Exp (18.3036 - (3816.44/ (T - 46.13)))
				MW	Molecular Weight of Water	18	g/mole	- -	** Adapted the equation in the S-B EMWP (2016).
				R	Ideal Gas Law constant	0.06237	$mmHg-m^3/(mole-K$	- -	
				T	Temperature of Sweat Lodge	339	K	- -	
				ρw	Density of Liquid Water	1,000	g/L	- -	
				CF4	Conversion Factor 4	1/24	day/hr	- -	

Notes:

(1) Calculated as the product of ED (years) x 365 days/year.

(2) Calculated as the product of 70 years assumed human lifetime (Harper, 2007) x 365 days/year.

(3) Children ages 2-6.

(4) EF (365 days/year) and ET (1 hour/day) based on Shoshane-Bannock, 2016. These exposure assumptions are more conservative than input provided by Quapaw and TCTCIT.

Sources:

EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final)). EPA/540/R/99/005. July.

EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6.

Harper, 2007. Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Report of Grant Number EPA-STAR-J1-R831046. August.

Harper, 2008. Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc.

Tar Creek Trustee Council Indian Tribes (TCTCIT). 2018. Responses to Draft Risk Assessment Guidance forSuperfund (RAGS) Part D Tables 1 through 6 provided for review on November 14, 2017.

Shoshone-Bannock Exposure Scenario for Use in Risk Assessment: Traditional Subsistence Lifeways. Shoshone-Bannock Tribes Environmental Waste Management Program (S-B EMWP). February 2016.

TABLE 4.6.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name (1)
Ingestion	Tribal Lifeway	Adult		C_{AB}	Chemical Concentration in Aquatic Biota	EPC	mg/kg	Calculated(†)	Chronic Daily Intake (CDI) (mg/kg-day)(†) =
			Fish Tissue	IR-F	Ingestion Rate of Fish	90	g/day	Harper, 2008 (3)	C_{AB} x IR-AB x EF x FI x ED x CF5 x 1/BW x 1/AT
			Shellfish Tissue	IR-Sf	Ingestion Rate of Shellfish	30	g/day	Harper, 2008 (4)	
			Amphibian/Aquatic Reptile Tissue	IR-TF	Ingestion Rate of Turtles, Frogs	24	g/day	Harper, 2008 (5)	
			Semi-Aquatic Mammals Tissue	IR-AM	Ingestion Rate of Semi-Aquatic Mammals	69	g/day	Harper, 2008 (6)	
				EF	Exposure Frequency	365	days/year	--	
				FI	Fraction Ingested from Contaminated Source	1	unitless	(8)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child		C_{AB}	Chemical Concentration in Aquatic Biota	EPC	mg/kg	Calculated(†)	CDI (mg/kg-day)(†) =
			Fish Tissue	IR-F	Ingestion Rate of Fish	45	g/day	(7)	C_{AB} x IR-AB x EF x FI x ED x CF5 x 1/BW x 1/AT
			Shellfish Tissue	IR-Sf	Ingestion Rate of Shellfish	15	g/day	(7)	
			Amphibian/Aquatic Reptile Tissue	IR-TF	Ingestion Rate of Turtles, Frogs	12	g/day	(7)	
			Semi-Aquatic Mammals Tissue	IR-AM	Ingestion Rate of Semi-Aquatic Mammals	35	g/day	(7)	
				EF	Exposure Frequency	365	days/year	--	
				FI	Fraction Ingested from Contaminated Source	1	unitless	(8)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child		C_{AB}	Chemical Concentration in Aquatic Biota	EPC	mg/kg	Calculated(†)	CDI (mg/kg-day)(†) =
			Fish Tissue	IR-F-Adj	Ingestion Rate of Fish, Age-adjusted	36,604	g/kg	Calculated	C_{AB} x IR-AB-Adj x FI x CF5 x 1/AT
			Shellfish Tissue	IR-Sf-Adj	Ingestion Rate of Shellfish, Age-adjusted	12,201	g/kg	Calculated	IR-AB-Adj (g/kg) =
			Amphibian/Aquatic Reptile Tissue	IR-TF-Adj	Ingestion Rate of Turtles, Frogs, Age-adjusted	9,761	g/kg	Calculated	(ED-C x EF-C x IR-AB-C / BW-C) + (ED-A x EF-C x IR-AB-A / BW-A)
			Semi-Aquatic Mammals Tissue	IR-AM-Adj	Ingestion Rate - Semi-Aquatic Mammals, Age-adjusted	28,063	g/kg	Calculated	
				EF	Exposure Frequency	365	days/year	--	
				FI	Fraction Ingested from Contaminated Source	1	unitless	(8)	
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
				CF5	Conversion Factor 5	0.001	kg/g	--	

TABLE 4.6.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Sediment/Surface Water (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Animal Tissue)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name (1)
Ingestion (cont'd)	General Public	Adult	Fish Tissue	C_{Fish}	Chemical Concentration in Fish	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-F	Ingestion Rate of Fish	67	g/day	Dong et al., 2015 (9)	C_{Fish} x IR-F x EF x FI x ED x CF5 x 1/BW x 1/AT
				EF	Exposure Frequency	365	days/year	--	
				FI	Fraction Ingested from Contaminated Source	1	unitless	(8)	
				ED	Exposure Duration	20	years	EPA, 2014	
				BW	Body Weight	80	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	7,300	days	(1)	
		Child	Fish Tissue	C_{Fish}	Chemical Concentration in Fish	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-F	Ingestion Rate of Fish	33.5	g/day	(7)	C_{Fish} x IR-F x EF x FI x ED x CF5 x 1/BW x 1/AT
				EF	Exposure Frequency	365	days/year	--	
				FI	Fraction Ingested from Contaminated Source	1	unitless	(8)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Fish Tissue	C_{Fish}	Chemical Concentration in Fish	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
				IR-F-Adj	Ingestion Rate of Fish, Age-adjusted	11,005	g/kg	Calculated	C_{Fish} x IR-F-Adj x FI x CF5 x 1/AT
				EF	Exposure Frequency	365	days/year	--	IR-F-Adj (g/kg) =
				FI	Fraction Ingested from Contaminated Source	1	unitless	(8)	(ED-C x EF-C x IR-F-C / BW-C) + (ED-A x EF-A x IR-F-A / BW-A)
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	
				CF5	Conversion Factor 5	0.001	kg/g	- -	

Notes:

(†) EPC and chemical intake will be calculated for each of four aquatic animal categories separately.

(1) Calculated as the product of ED (years) x 365 days/year.

(2) Calculated as the product of 70 years assumed human lifetime x 365 days/year.

(3) Assumes that 75'% of Harper (2008) "Aquatic & Fish" category is fish.

(4) Assumes that 25% of Harper (2008) "Aquatic & Fish" category is shellfish.

(5) Assumes that 35% of Harper (2008) "Small game" category is turtles and frogs.

(6) Assumes that 100% of Harper (2008) "Small game" category is semi-aquatic mammals.

(7) Based on a comparison of adult and child food consumption rates in the EPA Exposure Factor Handbook (2011) and Updates (2018), child consumption rate is assumed to be 50% of adult ingestion rate (see Table 4 Supplement C).

(8) Conservatively assumed that 100% of aquatic food items come from Operable Unit 5.

(9) Upper 95th confidence interval of mean fish consumption rate.

Sources:

EPA. 2011. Exposure Factors Handbook: 2011 Edition. PA/600/R-09/052F. September.

EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6.

Harper, 2007. Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Report of Grant Number EPA-STAR-J1-R831046. August.

Harper, 2008. Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc.

Tar Creek Trustee Council Indian Tribes (TCTCIT). 2018. Responses to Draft Risk Assessment Guidance forSuperfund (RAGS) Part D Tables 1 through 6 provided for review on November 14, 2017.

ODEQ. 2003. Fish Tissue Metals Analysis in the Tri-State Mining Area. FY 2003. Final Report. Section 106 Water Quality management Program I-006400-01. FY03/04 Carryover Project #8 (Task 600). July.

Dong et al. 2015. A longitudinal study of mercury exposure associated with consumption of freshwater fish from a reservoir in rural south central USA. Environmental Research. 155-162.

TABLE 4.7.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water/Sediment (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name (1)
Ingestion	Tribal Lifeway	Adult	Aquatic Plants	C_{AP}	Chemical Concentration in Aquatic Plant	EPC	mg/kg	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) =
			(as Food)	IR-AP	Ingestion Rate of Aquatic Plants	133	g/day	Harper, (2008) (3)	C_{AP} x IR-AP x EF x FI x ED x CF5 x 1/AT
			(Arrowhead and	EF	Exposure Frequency	365	days/year	--	
			Duckweed)	FI	Fraction Ingested from Contaminated Source	1	unitless	(5)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Aquatic Plants	C_{AP}	Chemical Concentration in Aquatic Plant	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
			(as Food)	IR-AP	Ingestion Rate of Aquatic Plants	67	g/day	(4)	C_{AP} x IR-AP x EF x FI x ED x CF5 x 1/AT
			(Arrowhead and	EF	Exposure Frequency	365	days/year	--	
			Duckweed)	FI	Fraction Ingested from Contaminated Source	1	unitless	(5)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Aquatic Plants	C_{AP}	Chemical Concentration in Aquatic Plant	EPC	mg/kg	Calculated	CDI (mg/kg-day) =
			(as Food)	IR-AP-Adj	Ingestion Rate of Aquatic Plants, Age-Adjusted	54,093	g/kg	Calculated	C_{AP} x IR-AP-Adj x FI x CF5 x 1/AT
			(Arrowhead and	AT-C	Averaging Time (Cancer)	25,550	days	(2)	IR-AP-Adj (g/kg) =
			Duckweed)	CF5	Conversion Factor 5	0.001	kg/g	- -	(ED-C x EF-C x IR-AP-C / BW-C) + (ED-A x EF-A x IR-AP-A / BW-A)

Notes:

(1) Calculated as the product of ED (years) x 365 days/year.

(2) Calculated as the product of 70 years assumed human lifetime x 365 days/year.

(3) Assumes that 100% of Harper (2008) "Roots & Bulbs" category is aquatic plants.

(4) Based on a comparison of adult and child food consumption rates in the EPA Exposure Factor Handbook (2011) and update (2018), child consumption rate is assumed to be 50% of adult ingestion rate (see Table 4 Supplement C).

(5) Conservatively assumed that 100% of aquatic plants come from Operable Unit 5.

Sources:

EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6.

Harper, 2007. Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Report of Grant Number EPA-STAR-J1-R831046. August.

Harper, 2008. Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc.

Tar Creek Trustee Council Indian Tribes (TCTCIT). 2018. Responses to Draft Risk Assessment Guidance for Superfund (RAGS) Part D Tables 1 through 6 provided for review on November 14, 2017.

TABLE 4.8.RME
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Medium: Surface Water/Sediment (Rivers and Creeks)
Exposure Medium: Aquatic Biota (Plant Tissue)

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal	Tribal Lifeway	Adult	Aquatic Plant (as Salve) (Arrowhead)	C_{AH}	Chemical Concentration in Arrowhead	EPC	mg/kg	Calculated	Chronic Daily Intake (CDI) (mg/kg-day) = C_{AH} x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	6,495	cm^2	Table 4 Supp A (3)	
				SSAF	Skin Adherence Factor	0.1	mg/cm^2-day	Harper, 2008 (4)	
				DABS	Dermal Absorption Factor	Chemical-specific	--	EPA, 2004 (4)	
				EF	Exposure Frequency	312	days/year	(5)	
				ED	Exposure Duration	64	years	Harper, 2007	
				BW	Body Weight	70	kg	Harper, 2008	
				AT-N	Averaging Time (Non-Cancer)	23,360	days	(1)	
		Child	Aquatic Plant (as Salve) (Arrowhead)	C_{AH}	Chemical Concentration in Arrowhead	EPC	mg/kg	Calculated	CDI (mg/kg-day) = C_{AH} x SA x SSAF x DABS x CF1 x EF x ED x 1/BW x 1/AT
				SA	Skin Surface Area Available for Contact	1,968	cm^2	Table 4 Supp B (3)	
				SSAF	Skin Adherence Factor	0.1	mg/cm^2-day	Harper, 2008 (4)	
				DABS	Dermal Absorption Factor	Chemical-specific	--	EPA, 2004 (4)	
				EF	Exposure Frequency	312	days/year	(5)	
				ED	Exposure Duration	6	years	EPA, 2014	
				BW	Body Weight	15	kg	EPA, 2014	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	(1)	
		Adult/Child	Aquatic Plant (as Salve) (Arrowhead)	C_{AH}	Chemical Concentration in Arrowhead	EPC	mg/kg	Calculated	CDI (mg/kg-day) = C_{AH} x DA-Adj x DABS x CF1 x 1/AT
				DA-Adj	Dermal Absorption, Age-adjusted	209,843	mg/kg	Calculated	
				AT-C	Averaging Time (Cancer)	25,550	days	(2)	DA-Adj (mg/kg) = (ED-C x EF-C x SA-C x SSAF-C / BW-C) + (ED-A x EF-A x SA-A x SSAF-A / BW-A)
				CF1	Conversion Factor 1	0.000001	kg/mg	- -	

Notes:

(1) Calculated as the product of ED (years) x 365 days/year.

(2) Calculated as the product of 70 years assumed human lifetime x 365 days/year.

(3) SA includes hands, forearms, face, lower legs, and feet (EPA, 2011).

(4) Assume the same as soil.

(5) Professional judgement based on input from TCTCIT.

Sources:

EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final)). EPA/540/R/99/005. July.

EPA, 2011: Exposure Factors Handbook. PA/600/R-09/052F.

EPA, 2014: Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors, OSWER Directive 9200.1-120, February 6.

Harper, 2007. Traditional Tribal Subsistence Exposure Scenario and Risk Assessment Guidance Manual. Report of Grant Number EPA-STAR-J1-R831046. August.

Harper, 2008. Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc.

Tar Creek Trustee Council Indian Tribes (TCTCIT). 2018. Responses to Draft Risk Assessment Guidance for Superfund (RAGS) Part D Tables 1 through 6 provided for review on November 14, 2017.

TABLE 4 SUPPLEMENT A

Skin Surface Area for Adult

REASONABLE MAXIMUM EXPOSURE

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Age Group	Skin Surface Area (m^2)								Exposed Skin Surface (m^2) (Face, Hands, Lower Arms, Lower Legs, and Feet)	Exposed Skin Surface (m^2) (Hands and Feet)
	Head	Face [2]	Arms	Hands	Feet	Forearms/ Arms Ratio	Forearms [3]	Lower Legs	Sum	Sum
Adult Male [1]	0.136	0.045	0.314	0.107	0.137	0.4713	0.148	0.268	0.705	0.244
Adult Female [1]	0.114	0.038	0.237	0.089	0.122	0.4713	0.112	0.233	0.594	0.211
					Average (m^2)				0.650	0.228
					Average (cm^2)				6,495	2,275

Notes:

(1) Based on Table 7-12 Recommended Mean Surface Area for Adult (Aged 21+ years) (EPA, 2011).

(2) Skin surface area for face is assumed to be 1/3 of head skin surface area.

(3) Forearms to arms skin area ratio was assumed to be 47%, based on ratio of forearms to arms ratio for males in Table 7-12 (EPA, 2011).

Reference:

EPA. 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-090/052F.

TABLE 4 SUPPLEMENT B
Skin Surface Area for Child
REASONABLE MAXIMUM EXPOSURE
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Age Group	Years	Skin Surface Area (m^2) [1]										Exposed Skin Surface (m^2) (Face, Hands, Lower Arms, Lower Legs, and Feet)		Exposed Skin Surface (m^2) (Hands and Feet)	
		Head	Face [2]	Arms	Hands	Legs	Feet	Forearms/ Arms Ratio [2]	Forearms	Lower Legs/ Legs Ratio [2]	Lower Legs	Sum	Weighted	Sum	Weighted
Birth to 1 month	0.08	0.053	0.018	0.040	0.015	0.060	0.019	0.450	0.018	0.400	0.024	0.094	0.008	0.034	0.003
1 to 3 months	0.17	0.060	0.020	0.045	0.017	0.068	0.021	0.450	0.020	0.400	0.027	0.105	0.018	0.038	0.006
3 to 6 months	0.25	0.069	0.023	0.052	0.020	0.078	0.025	0.450	0.023	0.400	0.031	0.123	0.031	0.045	0.011
6 to 12 months	0.5	0.082	0.027	0.062	0.024	0.093	0.029	0.450	0.028	0.400	0.037	0.145	0.073	0.053	0.027
1 to <2 years	1	0.087	0.029	0.069	0.030	0.122	0.033	0.450	0.031	0.400	0.049	0.172	0.172	0.063	0.063
2 to <3 years	1	0.051	0.017	0.088	0.028	0.154	0.038	0.450	0.040	0.400	0.062	0.184	0.184	0.066	0.066
3 to <6 years	3	0.061	0.020	0.106	0.037	0.195	0.049	0.450	0.048	0.400	0.078	0.232	0.696	0.086	0.258
										Weighted Average (m^2)			0.1968		0.0723
										Weighted Average (cm^2)			1,968		723

Note:
(1) Based on Table 7-2 Recommended Values for Surface Area of Body Parts (male and female combined) (EPA, 2011).
(2) Skin surface area for face is assumed to be 1/3 of head skin surface area, foreams are assumed to be 45% of the arms, and lower legs are assumed to be 40% of the legs (EPA, 2004).

Reference:
EPA, 2004 . Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (Final). EPA/540/R/99/005. July.
EPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-090/052F.

TABLE 4 SUPPLEMENT C

Estimation of Fraction of Child to Adult Food Ingestion Rates

REASONABLE MAXIMUM EXPOSURE

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Consumer Only Based- Data															
Age Group	Body Weight Table 8-3 (EPA, 2011) (kg)	Total Vegetable[a] Table 9-4 (EPA, 2018a) (g/kg-day)	(g/day)[b]	Child/Adult Fraction (%)[c]	Total Meat[a] Table 11-4 (EPA, 2018b) (g/kg-day)	(g/day)[b]	Child/Adult Fraction (%)[c]	Age Group (Aquatic)	Finfish[a] Table 10-8 (EPA, 2011) (g/kg-day)	(g/day)[b]	Child/Adult Fraction (%)[c]	Shellfish[a] Table 10-10 (EPA, 2011) (g/kg-day)	(g/day)[b]	Child/Adult Fraction (%)[c]
Mean Based Data								**Mean Based Data**						
0 to <1 year[f]	7.8	6.72	52.6	30%	3.02	23.7	19%	0 to <1 year	1.31	10.3	23%	0.42	3.3	7%
1 to <2 years	11.4	6.66	75.9	43%	4.05	46.2	36%	1 to 2 years	1.61	18.4	40%	0.94	10.7	24%
2 to <3 years	13.8	5.96	82.2	47%	4.25	58.7	46%	3 to 5 years	1.28	17.7	39%	1.00	13.8	31%
3 to <6 years	18.6	5.31	98.8	56%	4.01	74.6	59%	6 to 12 years	1.05	19.5	43%	0.72	13.4	30%
Adult	Time Weighted Average (TWA) =			48%	TWA =		46%		TWA =		37%	TWA =		25%
21 to < 50 years	70	2.52	176		1.82	127		20 to < 50 years	0.65	45.5		0.63	44.1	
Median Based Data								**Median Based Data**						
0 to <1 year[f]	7.8	5.4	41.9	29%	2.2	17.1	15%	0 to 1 year	0.8	6.2	22%	0.2	1.6	6%
1 to <2 years	11.3	5.3	59.9	41%	3.6	40.7	36%	1 to 2 years	0.8	9.0	32%	0.6	6.8	24%
2 to <3 years	13.6	5.0	68.0	46%	3.8	51.7	46%	3 to 5 years	1.0	13.6	49%	0.7	9.5	34%
3 to <6 years	17.8	4.1	73.0	50%	3.5	62.3	56%	6 to 12 years	0.7	12.5	45%	0.5	8.9	32%
Adult	TWA =			44%	TWA =		44%		TWA =		38%	TWA =		26%
21 to < 50 years[d]	70	2.1	147		1.6	112		20 to < 50 years	0.4	28.0		0.4	28.0	

TABLE 4 SUPPLEMENT C

Estimation of Fraction of Child to Adult Food Ingestion Rates

REASONABLE MAXIMUM EXPOSURE

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Per-Capita Based-Data

Age Group	Body Weight Table 8-3 (EPA, 2011)	Total Vegetable[a] Table 9-3 (EPA, 2018a)		Child/Adult Fraction	Total Meat[a] Table 11-3 (EPA, 2018b)		Child/Adult Fraction
		(g/kg-day)	(g/day)[b]	(%)[c]	(g/kg-day)	(g/day)[b]	(%)[c]
Mean Based Data							
0 to <1 year[f]	7.8	4.72	37.0	21%	1.26	9.9	8%
1 to <2 years	11.4	6.65	75.8	43%	3.94	44.9	36%
2 to <3 years	13.8	5.95	82.1	47%	4.17	57.5	46%
3 to <6 years	18.6	5.30	98.6	56%	3.96	73.7	59%
		TWA =		46%	TWA =		44%
Adult							
21 to < 50 years	70	2.52	176		1.79	125	
Median Based Data							
0 to <1 year[f]	7.8	2.9	22.5	15%	Note[g]		
1 to <2 years	11.3	5.3	59.9	41%	3.5	39.6	35%
2 to <3 years	13.6	5.0	68.0	46%	3.7	50.3	45%
3 to <6 years	17.8	4.1	73.0	50%	3.4	60.5	54%
		TWA =		42%	TWA[g] =		48%
Adult							
21 to < 50 years[d]	70	2.1	147		1.6	112	

Age Group (Aquatic)	Finfish[a] Table 10-7 (EPA, 2011)		Child/Adult Fraction	Shellfish[a] Table 10-9 (EPA, 2011)		Child/Adult Fraction
	(g/kg-day)	(g/day)[b]	(%)[c]	(g/kg-day)	(g/day)[b]	(%)[c]
Mean Based Data						
0 to <1 year	0.03	0.2	2%	Note[g]		
1 to 2 years	0.22	2.5	24%	0.04	0.5	8%
3 to 5 years	0.19	2.6	25%	0.05	0.7	12%
6 to 12 years	0.16	3.0	28%	0.05	0.9	17%
	TWA =		21%	TWA[g] =		10%
20 to < 50 years	0.15	10.5		0.08	5.6	
Median Based Data[e]						

Notes:

[a] Information about age-specific body weight and food consumption rates were obtained from EPA Exposure Factors Handbook (EFH) and its updates.

[b] Body weight adjusted food consumption rates (in g/kg-day) in the EFH are converted to consumption rates in grams per day by multiplying by age-specific body weight.

[c] Child/Adult fractions were calculated by dividing child food consumption rate by adult food consumption rate.

[d] Adult body weight of 70 kg was used.

[e] Because of the small % consuming (less than 50%), the estimates based on median are not presented.

[f] Body weight of child (0 to < 1 year old) is time weighted average.

[g] Because of lack of measurable ingestion rate for child (0 to <1 year old), TWA ingestion rate was estimated child (1 to <6 years old).

References:

EPA. 2011. Exposure Factors Handbook: 2011 Edition. PA/600/R-09/052F. September.

EPA. 2018a. Update for Chapter 9 of the Exposure Factors Handbook. Intake of Fruits and Vegetables. EPA/600/R-18/098F. August.

EPA. 2018b. Update for Chapter 11 of the Exposure Factors Handbook. Intake of Meats, Dairy Products, and Fats. EPA/600/R-17/485F. August.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Aluminum	Chronic	1.0E+00	mg/kg-day	100%	1.0E+00	mg/kg-day	Nervous	100	PPRTV	10/23/2006
Antimony	Chronic	4.0E-04	mg/kg-day	15%	6.0E-05	mg/kg-day	Hematologic, Whole Body	1000	IRIS	11/6/2019
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	3.0E-04	mg/kg-day	Cardiovascular, Dermal	3 / 1	IRIS	11/6/2019
Barium	Chronic	2.0E-01	mg/kg-day	7%	1.4E-02	mg/kg-day	Urinary	300	IRIS	11/6/2019
Beryllium	Chronic	2.0E-03	mg/kg-day	0.7%	1.4E-05	mg/kg-day	Gastrointestinal	300	IRIS	11/6/2019
Boron	Chronic	2.0E-01	mg/kg-day	100%	2.0E-01	mg/kg-day	Developmental	66	IRIS	11/6/2019
Cadmium (other than water) (3)	Chronic	1.0E-03	mg/kg-day	2.5%	2.5E-05	mg/kg-day	Urinary	10	IRIS	11/6/2019
Cadmium (water)	Chronic	5.0E-04	mg/kg-day	5%	2.5E-05	mg/kg-day	Urinary	10	IRIS	11/6/2019
Chromium (trivalent) (4)	Chronic	1.5E+00	mg/kg-day	1.3%	2.0E-02	mg/kg-day	NOE	100 / 10	IRIS	11/6/2019
Chromium (hexavalent) (4)	Chronic	3.0E-03	mg/kg-day	2.5%	7.5E-05	mg/kg-day	NOE	300 / 3	IRIS	11/6/2019
Cobalt	Chronic	3.0E-04	mg/kg-day	100%	3.0E-04	mg/kg-day	Thyroid	3000	PPRTV	8/25/2008
Copper	Chronic	4.0E-02	mg/kg-day	100%	4.0E-02	mg/kg-day	Gastrointestinal	NA	HEAST	7/31/1997
Iron	Chronic	7.0E-01	mg/kg-day	100%	7.0E-01	mg/kg-day	Gastrointestinal	1.5	PPRTV	9/11/2006
Lead	Chronic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lithium	Chronic	2.0E-03	mg/kg-day	100%	2.0E-03	mg/kg-day	Not specified (9)	1000	PPRTV	6/12/2008
Manganese (diet)	Chronic	1.4E-01	mg/kg-day	100%	1.4E-01	mg/kg-day	Nervous	1	IRIS	11/6/2019
Manganese (non-diet) (5)	Chronic	2.4E-02	mg/kg-day	4%	9.6E-04	mg/kg-day	Nervous	1	IRIS (5)	11/6/2019
Mercury (mercuric chloride) (6)	Chronic	3.0E-04	mg/kg-day	7%	2.1E-05	mg/kg-day	Immune, Urinary	1000	IRIS	11/6/2019
Mercury (methylmercury) (6)	Chronic	1.0E-04	mg/kg-day	100%	1.0E-04	mg/kg-day	Developmental, Nervous	NA	IRIS	11/6/2019
Molybdenum	Chronic	5.0E-03	mg/kg-day	100%	5.0E-03	mg/kg-day	Urinary	30 / 1	IRIS	11/6/2019
Nickel	Chronic	2.0E-02	mg/kg-day	4%	8.0E-04	mg/kg-day	Whole Body	300 / 1	IRIS	11/6/2019
Phosphorus (7)	Chronic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	Chronic	5.0E-03	mg/kg-day	100%	5.0E-03	mg/kg-day	Nervous, Hematologic, Dermal	3	IRIS	11/6/2019
Silica	Chronic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	Chronic	5.0E-03	mg/kg-day	4%	2.0E-04	mg/kg-day	Dermal	3	IRIS	11/6/2019
Strontium	Chronic	6.0E-01	mg/kg-day	100%	6.0E-01	mg/kg-day	Musculoskeletal	300	IRIS	11/6/2019
Thallium (8)	Chronic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium (9)	Chronic	5.0E-03	mg/kg-day	2.6%	1.3E-04	mg/kg-day	Dermal	100 / 1	IRIS (8)	11/6/2019
Zinc	Chronic	3.0E-01	mg/kg-day	100%	3.0E-01	mg/kg-day	Immune, Hematologic	3	IRIS	11/6/2019

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)

Notes:

(1) Source: Risk Assessment Guidance for Superfund (RAGS). Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1. EPA recommends that the oral RfD should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%. Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.
(2) Adjusted based on RAGS Part E.
(3) Toxicity values used for exposure through media other than water (sediment, plant, fish, meat).
(4) Chromium (hexavalent) toxicity values used for exposure through aqueous media such as surface water, whereas chromium (trivalent) toxicity values used for exposure through solid media such as food.
(5) The RfD for manganese is based on non-diet sources. The RfD (0.14 mg/kg-day) presented in IRIS includes manganese from all sources, including diet. This RfD was adjusted by subtracting the dietary contribution from the normal U.S. diet (an upper limit of 5 mg/day) and applying a modifying factor of 3 to address uncertainties associated with non-food manganese exposure sources.
(6) Mercury is assumed to be present as mercuric chloride (and other Mercury salts) in sediment and surface water. whereas mercury is assumed to be present as methylmercury in food (animal meat and plants).
(7) No toxicity values were available for the form of phosphorus (adsorbed orthophosphate) expected to be found at the site.
(8) Due to increased uncertainty, PPRTV Appendix toxicity value was not used in the quantitative evaluation of non-carcinogenic hazard.
(9) Consistent with EPA's (November 2019) RSL table, the RfD for vanadium was derived from the IRIS oral RfD for vanadium pentoxide by factoring out the molecular weight of the oxide ion. Vanadium pentoxide has a molecular weight (MW) of 181.88. The two atoms of vanadium contribute 56% of the MW. Vanadium pentoxide's oral RfD of 9E-03 mg/kg-day multiplied by 56% gives a vanadium oral RfD of 5.04E-03 mg/kg-day.
(9) Primary target organs and critical effects for lithium are not specified in the PPRTV document. Studies presented in the PPRTV document indicate lithium exposure is associated with adverse effects on the following target organs/systems: urinary, nervous, endocrine, reproductive, hematological, and developmental.

Definitions:

EPA = U.S. Environmental Protection Agency
HEAST = Health Effects Summary Tables
IRIS = Integrated Risk Information System
NA = Not Available
NOE = No Observed Effect
PPRTV = Provisional Peer-Reviewed Toxicity Value
RfD = Reference Dose
RSL = Regional Screening Level
mg/kg-day = milligram per kilogram per day

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Aluminum	Chronic	5.0E-03	mg/m^3	Nervous	300	PPRTV	10/23/2006
Antimony	Chronic	NA	NA	NA	NA	NA	NA
Arsenic	Chronic	1.5E-05	mg/m^3	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	30	Cal/EPA	11/6/2019
Barium	Chronic	5.0E-04	mg/m^3	Developmental	1000	HEAST	07/31/1997
Beryllium	Chronic	2.0E-05	mg/m^3	Immune, Respiratory	10	IRIS	11/6/2019
Boron	Chronic	2.0E-02	mg/m^3	Respiratory	100	HEAST	07/1/1997
Cadmium	Chronic	1.0E-05	mg/m^3	Urinary	9	ATSDR	9/1/2012
Chromium (hexavalent) (1)	Chronic	8.0E-06	mg/m^3	Respiratory	90	IRIS	11/6/2019
Cobalt	Chronic	6.0E-06	mg/m^3	Respiratory	300	PPRTV	8/25/2008
Copper	Chronic	NA	NA	NA	NA	NA	NA
Iron	Chronic	NA	NA	NA	NA	NA	NA
Lead	Chronic	NA	NA	NA	NA	NA	NA
Lithium	Chronic	NA	NA	NA	NA	NA	NA
Manganese	Chronic	5.0E-05	mg/m^3	Nervous	1000	IRIS	11/6/2019
Mercury (2)	Chronic	NA	NA	NA	NA	NA	NA
Molybdenum	Chronic	NA	NA	NA	NA	NA	NA
Nickel	Chronic	9.0E-05	mg/m^3	Respiratory	30	ATSDR	8/1/2005
Phosphorus	Chronic	NA	NA	NA	NA	NA	NA
Selenium	Chronic	2.0E-02	mg/m^3	Hepatic, Cardiovascular, Nervous	3	Cal/EPA	11/6/2019
Silica (3)	Chronic	NA	NA	NA	NA	NA	NA
Silver	Chronic	NA	NA	NA	NA	NA	NA
Strontium	Chronic	NA	NA	NA	NA	NA	NA
Thallium	Chronic	NA	NA	NA	NA	NA	NA
Vanadium	Chronic	1.0E-04	mg/m^3	Respiratory	30	ATSDR	9/1/2012
Zinc	Chronic	NA	NA	NA	NA	NA	NA

Notes:

(1) RfC for chromic acid mists and dissolved Cr(VI) aerosols was used.
(2) Although an RfC is available for elemental mercury, this RfC was not used in the evaluation of mercury at OU 5 because it is assumed that mercury is present as mercuric chloride (and other mercury salts) in sediment and surface water and is present as methylmercury in food (animal meat and plants).
(3) The RfC presented on the RSL table is meant to be applied only to particles of crystalline silica (quartz, cristobalite, tridymite), of respirable size; therefore, no RfC value is identified for silica in water vapor.

Definitions:

ATSDR = Agency for Toxic Substances & Disease Registry Minimal Risk Levels
Cal/EPA = California Environmental Protection Agency
HEAST = Health Effects Summary Tables
IRIS = Integrated Risk Information System
mg/m^3 = milligram per cubic meter
NA = Not Available
OU 5 = Operable Unit 5
PPRTV = Provisional Peer-Reviewed Toxicity Value
RfC = Reference Concentration
RSL = Regional Screening Level

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal -1	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	1.5E+00	$(mg/kg\text{-}day)^{-1}$	100%	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	11/6/2019
Barium	NA	NA	NA	NA	NA	D	IRIS	11/6/2019
Beryllium	NA	NA	NA	NA	NA	Carcinogenic potential cannot be determined	IRIS	11/6/2019
Boron	NA	NA	NA	NA	NA	Data are inadequate for an assessment of human carcinogenic potential	IRIS	11/6/2019
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (trivalent)	NA	NA	NA	NA	NA	D	IRIS	11/6/2019
Chromium (hexavalent)	5.0E-01	$(mg/kg\text{-}day)^{-1}$	2.5%	2.0E+01	$(mg/kg\text{-}day)^{-1}$	D; Carcinogenic potential cannot be determined	Cal/EPA	11/6/2019
Cobalt	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	D	IRIS	11/6/2019
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA
Lithium	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	D	IRIS	11/6/2019
Mercury (mercuric chloride) (3)	NA	NA	NA	NA	NA	C	IRIS	11/6/2019
Mercury (methylmercury) (3)	NA	NA	NA	NA	NA	C	IRIS	11/6/2019
Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Phosphorus	NA	NA	NA	NA	NA	D	IRIS	11/6/2019
Selenium	NA	NA	NA	NA	NA	D	IRIS	11/6/2019
Silica	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	NA	NA	NA	NA	D	IRIS	11/6/2019
Strontium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	Inadequate information to assess carcinogenic potential	IRIS	11/6/2019

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal -1	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)

Notes:

(1) Source: Risk Assessment Guidance for Superfund (RAGS). Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1. EPA recommends that the oral slope factor should not be adjusted to estimate the absorbed dose for compounds when the absorption efficiency is greater than 50%. Constituents that do not have oral absorption efficiencies reported on this table were assumed to have an oral absorption efficiency of 100%.

(2) Adjusted based on RAGS Part E.

(3) Mercury is assumed to be present as mercuric chloride (and other Mercury salts) in sediment and surface water. whereas mercury is assumed to be present as methylmercury in food (animal meat and plants).

Definitions:

Cal/EPA = California Environmental Protection Agency
CSF = Cancer Slope Factor
IRIS = Integrated Risk Information System
NA = Not Available
mg/kg-day = milligram per kilogram per day

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.
Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals and inadequate or a lack of human data.
Group D chemicals (not classifiable as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chemical of Potential Concern	Unit Risk		Weight of Evidence/ Cancer Guideline Description	Unit Risk	
	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Aluminum	NA	NA	NA	NA	NA
Antimony	NA	NA	NA	NA	NA
Arsenic	4.3E-03	$(\mu g/m^3)^{-1}$	A	IRIS	11/6/2019
Barium	NA	NA	D	IRIS	11/6/2019
Beryllium	2.4E-03	$(\mu g/m^3)^{-1}$	Known/likely human carcinogen	IRIS	11/6/2019
Boron	NA	NA	NA	NA	NA
Cadmium	1.8E-03	$(\mu g/m^3)^{-1}$	B1	IRIS	11/6/2019
Chromium (hexavalent)	8.4E-02	$(\mu g/m^3)^{-1}$	A; Known/likely human carcinogen	IRIS (1)	11/6/2019
Cobalt	9.0E-03	$(\mu g/m^3)^{-1}$	Likely to be carcinogenic to humans by inhalation route	PPRTV	8/25/2008
Copper	NA	NA	D	IRIS	11/6/2019
Iron	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA
Lithium	NA	NA	NA	NA	NA
Manganese	NA	NA	D	IRIS	11/6/2019
Mercury	NA	NA	C	IRIS	11/6/2019
Molybdenum	NA	NA	NA	NA	NA
Nickel	2.6E-04	$(\mu g/m^3)^{-1}$	NA	Cal/EPA	11/6/2019
Phosphorus	NA	NA	D	IRIS	11/6/2019
Selenium	NA	NA	D	IRIS	11/6/2019
Silica	NA	NA	NA	NA	NA
Silver	NA	NA	D	IRIS	11/6/2019
Strontium	NA	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA
Zinc	NA	NA	Inadequate information to assess carcinogenic potential	IRIS	11/6/2019

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chemical of Potential Concern	Unit Risk		Weight of Evidence/ Cancer Guideline Description	Unit Risk	
	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)

Notes:

(1) Consistent with EPA's (November 2019) RSL table, the unit risk for hexavalent chromium is derived by multiplying the IRIS hexavalent chromium value by 7. This is considered to be a health-protective assumption, and is also consistent with the State of California's interpretation of the Mancuso study that forms the basis of hexavalent chromium's estimated cancer potency.

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.
Group B1 chemicals (probable human carcinogens) are agents for which there is limited evidence of possible carcinogenicity in humans.
Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals and inadequate or a lack of human data.
Group D chemicals (not classifiable as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

Definitions:

EPA = Environmental Protection Agency
Cal/EPA = California Environmental Protection Agency
IRIS = Integrated Risk Information System
NA = Not Available
PPRTV = Provisional Peer-Reviewed Toxicity Value
RSL = Regional Screening Level
$\mu g/m^3$ = microgram per cubic meter

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	5.3E-02	mg/kg/day	1.0E+00	mg/kg/day	5.3E-02
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	4.0E-04	mg/kg/day	4.5E-02
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	3.0E-04	mg/kg/day	1.1E-01
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	2.1E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	9.8E-06	mg/kg/day	2.0E-03	mg/kg/day	4.9E-03
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	5.7E-04	mg/kg/day	1.0E-03	mg/kg/day	5.7E-01
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	1.5E+00	mg/kg/day	1.8E-04
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	4.0E-02	mg/kg/day	2.6E-02
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	7.0E-01	mg/kg/day	1.9E-01
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	2.1E-02	mg/kg/day	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-03	mg/kg/day	6.1E-02
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	2.4E-02	mg/kg/day	1.3E-01
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	3.0E-04	mg/kg/day	8.0E-03
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	2.0E-02	mg/kg/day	7.2E-03
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	5.0E-03	mg/kg/day	6.7E-03
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	5.0E-03	mg/kg/day	5.1E-04
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-04	mg/kg/day	6.0E-01	mg/kg/day	6.1E-04
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	4.9E-06	mg/kg/day	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	5.0E-03	mg/kg/day	7.0E-02
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	5.3E-01	mg/kg/day	3.0E-01	mg/kg/day	1.8E+00
			Exp. Route Total								NA					3.3E+00

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	8.2E-06	mg/kg/day	3.0E-04	mg/kg/day	2.7E-02
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	2.5E-05	mg/kg/day	1.1E-01
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.4E-01
		Exposure Point Total									NA					3.5E+00
	Exposure Medium Total										NA					3.5E+00
Medium Total											NA					3.5E+00

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	1.0E+00	mg/kg/day	4.8E-03
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	4.0E-04	mg/kg/day	3.7E-02
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	3.0E-04	mg/kg/day	7.0E-02
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	4.8E-04	mg/kg/day	2.0E-01	mg/kg/day	2.4E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	2.6E-04	mg/kg/day	5.0E-04	mg/kg/day	5.2E-01
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-03	mg/kg/day	6.2E-03
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	3.0E-04	mg/kg/day	1.8E-01
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	9.6E-05	mg/kg/day	4.0E-02	mg/kg/day	2.4E-03
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	6.3E-03	mg/kg/day	7.0E-01	mg/kg/day	9.1E-03
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	4.3E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	2.4E-02	mg/kg/day	1.8E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	2.0E-02	mg/kg/day	6.3E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	3.4E-06	mg/kg/day	5.0E-03	mg/kg/day	6.7E-04
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	3.0E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					1.2E+00
			Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	1.0E+00	mg/kg/day	1.0E-03
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	6.0E-05	mg/kg/day	5.3E-02
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	4.5E-06	mg/kg/day	3.0E-04	mg/kg/day	1.5E-02
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	1.4E-02	mg/kg/day	7.3E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	5.6E-05	mg/kg/day	2.5E-05	mg/kg/day	2.2E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	7.9E-06	mg/kg/day	7.5E-05	mg/kg/day	1.1E-01
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	4.5E-06	mg/kg/day	3.0E-04	mg/kg/day	1.5E-02
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	4.0E-02	mg/kg/day	5.1E-04
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	7.0E-01	mg/kg/day	1.9E-03
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	9.2E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	9.4E-04	mg/kg/day	9.6E-04	mg/kg/day	9.8E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	5.4E-06	mg/kg/day	8.0E-04	mg/kg/day	6.8E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	7.2E-07	mg/kg/day	5.0E-03	mg/kg/day	1.4E-04
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	1.3E-04	mg/kg/day	2.4E-02
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	5.8E-03	mg/kg/day	3.0E-01	mg/kg/day	1.9E-02
			Exp. Route Total								NA					3.5E+00
		Exposure Point Total									NA					4.6E+00

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	2.6E-02	mg/kg/day	1.0E+00	mg/kg/day	2.6E-02
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	4.0E-04	mg/kg/day	2.0E-01
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.7E-01
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	2.0E-01	mg/kg/day	1.3E-02
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	5.0E-04	mg/kg/day	2.8E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	9.9E-05	mg/kg/day	3.0E-03	mg/kg/day	3.3E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	3.0E-04	mg/kg/day	9.3E-01
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.3E-02
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	3.4E-02	mg/kg/day	7.0E-01	mg/kg/day	4.8E-02
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	2.4E-02	mg/kg/day	9.7E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	2.0E-02	mg/kg/day	3.4E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	5.0E-03	mg/kg/day	3.6E-03
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	5.0E-03	mg/kg/day	1.6E-02
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	2.4E-01	mg/kg/day	3.0E-01	mg/kg/day	8.0E-01
			Exp. Route Total								NA					6.2E+00
			Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	1.0E+00	mg/kg/day	1.4E-04
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.4E-07	mg/kg/day	6.0E-05	mg/kg/day	7.3E-03
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	6.2E-07	mg/kg/day	3.0E-04	mg/kg/day	2.1E-03
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.4E-02	mg/kg/day	1.0E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	7.7E-06	mg/kg/day	2.5E-05	mg/kg/day	3.1E-01
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	7.5E-05	mg/kg/day	1.5E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	6.2E-07	mg/kg/day	3.0E-04	mg/kg/day	2.1E-03
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	4.0E-02	mg/kg/day	7.1E-05
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	7.0E-01	mg/kg/day	2.7E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	9.6E-04	mg/kg/day	1.4E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	7.5E-07	mg/kg/day	8.0E-04	mg/kg/day	9.4E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	5.0E-03	mg/kg/day	2.0E-05
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.4E-07	mg/kg/day	1.3E-04	mg/kg/day	3.4E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	3.0E-01	mg/kg/day	2.7E-03
			Exp. Route Total								NA					4.8E-01
		Exposure Point Total									NA					6.7E+00

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.0E-02	mg/kg/day	1.0E+00	mg/kg/day	1.0E-02
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	4.0E-04	mg/kg/day	7.9E-02
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	2.0E-01	mg/kg/day	5.1E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	5.5E-04	mg/kg/day	5.0E-04	mg/kg/day	1.1E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	3.0E-03	mg/kg/day	1.3E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.7E-01
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	5.1E-03
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	7.0E-01	mg/kg/day	1.9E-02
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	9.1E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	9.4E-03	mg/kg/day	2.4E-02	mg/kg/day	3.9E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	2.0E-02	mg/kg/day	1.3E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	7.1E-06	mg/kg/day	5.0E-03	mg/kg/day	1.4E-03
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	5.0E-03	mg/kg/day	6.3E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	9.6E-02	mg/kg/day	3.0E-01	mg/kg/day	3.2E-01
			Exp. Route Total								NA					2.5E+00
			Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E+00	mg/kg/day	2.0E-04
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.2E-07	mg/kg/day	6.0E-05	mg/kg/day	1.0E-02
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	8.7E-07	mg/kg/day	3.0E-04	mg/kg/day	2.9E-03
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.4E-02	mg/kg/day	1.4E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	2.5E-05	mg/kg/day	4.3E-01
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	7.5E-05	mg/kg/day	2.1E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	8.8E-07	mg/kg/day	3.0E-04	mg/kg/day	2.9E-03
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	4.0E-06	mg/kg/day	4.0E-02	mg/kg/day	1.0E-04
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	2.6E-04	mg/kg/day	7.0E-01	mg/kg/day	3.8E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	9.6E-04	mg/kg/day	1.9E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	8.0E-04	mg/kg/day	1.3E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	5.0E-03	mg/kg/day	2.8E-05
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.2E-07	mg/kg/day	1.3E-04	mg/kg/day	4.8E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	3.0E-01	mg/kg/day	3.8E-03
			Exp. Route Total								NA					6.7E-01
		Exposure Point Total									NA					3.2E+00

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	1.2E-01	mg/m^3	NA	NA	NA	NA	NA	5.0E-03	mg/m^3	5.0E-03	mg/m3	9.9E-01
				Antimony	3.7E-04	mg/m^3	NA	NA	NA	NA	NA	1.5E-05	mg/m^3	NA	NA	NA
				Arsenic	5.1E-04	mg/m^3	NA	NA	NA	NA	NA	2.1E-05	mg/m^3	1.5E-05	mg/m3	1.4E+00
				Barium	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	4.9E-04	mg/m^3	5.0E-04	mg/m3	9.8E-01
				Cadmium (water)	6.4E-03	mg/m^3	NA	NA	NA	NA	NA	2.7E-04	mg/m^3	1.0E-05	mg/m3	2.7E+01
				Chromium (hexavalent)	4.6E-04	mg/m^3	NA	NA	NA	NA	NA	1.9E-05	mg/m^3	8.0E-06	mg/m3	2.4E+00
				Cobalt	1.3E-03	mg/m^3	NA	NA	NA	NA	NA	5.4E-05	mg/m^3	6.0E-06	mg/m3	9.0E+00
				Copper	2.4E-03	mg/m^3	NA	NA	NA	NA	NA	9.9E-05	mg/m^3	NA	NA	NA
				Iron	1.6E-01	mg/m^3	NA	NA	NA	NA	NA	6.5E-03	mg/m^3	NA	NA	NA
				Lead	1.1E-02	mg/m^3	NA	NA	NA	NA	NA	4.4E-04	mg/m^3	NA	NA	NA
				Manganese (non-diet)	1.1E-01	mg/m^3	NA	NA	NA	NA	NA	4.5E-03	mg/m^3	5.0E-05	mg/m3	9.1E+01
				Nickel	3.1E-03	mg/m^3	NA	NA	NA	NA	NA	1.3E-04	mg/m^3	9.0E-05	mg/m3	1.4E+00
				Selenium	8.3E-05	mg/m^3	NA	NA	NA	NA	NA	3.5E-06	mg/m^3	2.0E-02	mg/m3	1.7E-04
				Vanadium	3.7E-04	mg/m^3	NA	NA	NA	NA	NA	1.5E-05	mg/m^3	1.0E-04	mg/m3	1.5E-01
				Zinc	1.1E+00	mg/m^3	NA	NA	NA	NA	NA	4.6E-02	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					1.3E+02
		Exposure Point Total									NA					1.3E+02
	Exposure Medium Total										NA					1.5E+02
Medium Total											NA					1.5E+02

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	1.0E+00	mg/kg/day	6.6E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.8E-01
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.6E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-03	mg/kg/day	6.9E-03
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	1.0E-03	mg/kg/day	8.5E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	1.5E+00	mg/kg/day	3.9E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	7.0E-01	mg/kg/day	2.0E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.4E-01	mg/kg/day	7.6E-02
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	1.0E-04	mg/kg/day	5.3E-01
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	5.9E-03
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	5.0E-03	mg/kg/day	2.1E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	5.0E-03	mg/kg/day	6.7E-02
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-03	mg/kg/day	4.6E-02
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	3.0E-01	mg/kg/day	1.3E-01
			Exp. Route Total								NA					2.3E+00
		Exposure Point Total									NA					2.3E+00

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	6.0E-02	mg/kg/day	1.0E+00	mg/kg/day	6.0E-02
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-04	mg/kg/day	8.3E-01
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-02	mg/kg/day	2.0E-01	mg/kg/day	2.2E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-03	mg/kg/day	8.1E-02
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	1.0E-03	mg/kg/day	2.7E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.7E-02
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	4.0E-02	mg/kg/day	3.3E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	7.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.0E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	5.2E-01	mg/kg/day	1.4E-01	mg/kg/day	3.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	1.0E-04	mg/kg/day	5.1E-02
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.3E-03
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	5.0E-03	mg/kg/day	7.5E-01
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	5.0E-03	mg/kg/day	6.2E-02
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	3.0E-01	mg/kg/day	6.6E-01
			Exp. Route Total								NA					6.9E+00
		Exposure Point Total									NA					6.9E+00

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	1.5E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.3E-02
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.7E-03
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.0E-03	mg/kg/day	3.4E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.0E-03	mg/kg/day	2.0E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.0E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	5.0E-03
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-03	mg/kg/day	7.0E-01	mg/kg/day	4.0E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.4E-01	mg/kg/day	9.9E-03
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-06	mg/kg/day	1.0E-04	mg/kg/day	5.9E-02
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	2.0E-02	mg/kg/day	2.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	5.0E-03	mg/kg/day	5.7E-02
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	6.9E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-03	mg/kg/day	3.0E-01	mg/kg/day	3.1E-02
			Exp. Route Total								NA					2.8E-01
		Exposure Point Total									NA					2.8E-01

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	1.0E+00	mg/kg/day	4.8E-03
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.6E-01
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	2.0E-01	mg/kg/day	5.3E-04
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	2.0E-03	mg/kg/day	2.0E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E-03	mg/kg/day	4.6E-02
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	1.5E+00	mg/kg/day	2.1E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	4.0E-02	mg/kg/day	3.6E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	7.0E-01	mg/kg/day	5.4E-02
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	1.4E-01	mg/kg/day	2.4E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	1.0E-04	mg/kg/day	5.7E-01
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	2.0E-02	mg/kg/day	1.8E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					2.0E+00
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total										NA					1.1E+01

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	7.4E-01	mg/kg/day	1.0E+00	mg/kg/day	7.4E-01
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	3.0E-04	mg/kg/day	9.7E-01
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	2.0E-01	mg/kg/day	2.0E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	2.0E-03	mg/kg/day	3.9E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	1.0E-03	mg/kg/day	2.8E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	1.5E+00	mg/kg/day	3.4E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	7.1E-03	mg/kg/day	3.0E-04	mg/kg/day	2.4E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-02	mg/kg/day	4.0E-02	mg/kg/day	9.1E-01
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+01	mg/kg/day	7.0E-01	mg/kg/day	1.7E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	5.7E-01	mg/kg/day	1.4E-01	mg/kg/day	4.1E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	8.6E-05	mg/kg/day	1.0E-04	mg/kg/day	8.6E-01
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-02	mg/kg/day	1.6E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.5E-02
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	5.0E-03	mg/kg/day	9.5E-01
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+00	mg/kg/day	3.0E-01	mg/kg/day	9.1E+00
			Exp. Route Total								NA					8.8E+01
		Exposure Point Total									NA					8.8E+01

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	3.0E-04	mg/kg/day	7.2E-04
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	2.5E-05	mg/kg/day	6.7E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.4E-03
		Exposure Point Total									NA					7.4E-03
	Exposure Medium Total										NA					8.8E+01
Medium Total											NA					1.0E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					3E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.1.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	312	234
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	7.2E-01	1.0E-03	6.0	4.3E-06	6.0	4.3E-06	2.7E+01
Antimony	2.2E-03	1.0E-03	6.0	1.3E-08	6.0	1.3E-08	8.2E-02
Arsenic	3.1E-03	1.0E-03	6.0	1.9E-08	6.0	1.9E-08	1.2E-01
Barium	7.1E-02	1.0E-03	6.0	4.3E-07	6.0	4.3E-07	2.6E+00
Cadmium (water)	3.9E-02	1.0E-03	6.0	2.3E-07	6.0	2.3E-07	1.4E+00
Chromium (hexavalent)	2.8E-03	2.0E-03	6.0	3.3E-08	6.0	3.3E-08	2.1E-01
Cobalt	7.8E-03	4.0E-04	6.0	1.9E-08	6.0	1.9E-08	1.2E-01
Copper	1.4E-02	1.0E-03	6.0	8.6E-08	6.0	8.6E-08	5.3E-01
Iron	9.4E-01	1.0E-03	6.0	5.6E-06	6.0	5.6E-06	3.5E+01
Lead	6.4E-02	1.0E-04	6.0	3.8E-08	6.0	3.8E-08	2.4E-01
Manganese (non-diet)	6.6E-01	1.0E-03	6.0	3.9E-06	6.0	3.9E-06	2.4E+01
Nickel	1.9E-02	2.0E-04	6.0	2.3E-08	6.0	2.3E-08	1.4E-01
Selenium	5.0E-04	1.0E-03	6.0	3.0E-09	6.0	3.0E-09	1.9E-02
Vanadium	2.2E-03	1.0E-03	6.0	1.3E-08	6.0	1.3E-08	8.2E-02
Zinc	6.7E+00	6.0E-04	6.0	2.4E-05	6.0	2.4E-05	1.5E+02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.1.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	7.2E-01	1.0E-03	0.71	5.1E-07	0.54	3.9E-07	3.7E+00
Antimony	2.2E-03	1.0E-03	0.71	1.6E-09	0.54	1.2E-09	1.1E-02
Arsenic	3.1E-03	1.0E-03	0.71	2.2E-09	0.54	1.7E-09	1.6E-02
Barium	7.1E-02	1.0E-03	0.71	5.0E-08	0.54	3.8E-08	3.7E-01
Cadmium (water)	3.9E-02	1.0E-03	0.71	2.7E-08	0.54	2.1E-08	2.0E-01
Chromium (hexavalent)	2.8E-03	2.0E-03	0.71	3.9E-09	0.54	3.0E-09	2.8E-02
Cobalt	7.8E-03	4.0E-04	0.71	2.2E-09	0.54	1.7E-09	1.6E-02
Copper	1.4E-02	1.0E-03	0.71	1.0E-08	0.54	7.7E-09	7.4E-02
Iron	9.4E-01	1.0E-03	0.71	6.7E-07	0.54	5.1E-07	4.8E+00
Lead	6.4E-02	1.0E-04	0.71	4.5E-09	0.54	3.4E-09	3.3E-02
Manganese (non-diet)	6.6E-01	1.0E-03	0.71	4.7E-07	0.54	3.5E-07	3.4E+00
Nickel	1.9E-02	2.0E-04	0.71	2.7E-09	0.54	2.0E-09	1.9E-02
Selenium	5.0E-04	1.0E-03	0.71	3.6E-10	0.54	2.7E-10	2.6E-03
Vanadium	2.2E-03	1.0E-03	0.71	1.6E-09	0.54	1.2E-09	1.1E-02
Zinc	6.7E+00	6.0E-04	0.71	2.9E-06	0.54	2.2E-06	2.1E+01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.1.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Sweat Lodge

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	4
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	7.2E-01	1.0E-03	1.0	7.2E-07	1.0	7.2E-07	5.2E+00
Antimony	2.2E-03	1.0E-03	1.0	2.2E-09	1.0	2.2E-09	1.6E-02
Arsenic	3.1E-03	1.0E-03	1.0	3.1E-09	1.0	3.1E-09	2.2E-02
Barium	7.1E-02	1.0E-03	1.0	7.1E-08	1.0	7.1E-08	5.1E-01
Cadmium (water)	3.9E-02	1.0E-03	1.0	3.9E-08	1.0	3.9E-08	2.8E-01
Chromium (hexavalent)	2.8E-03	2.0E-03	1.0	5.5E-09	1.0	5.5E-09	4.0E-02
Cobalt	7.8E-03	4.0E-04	1.0	3.1E-09	1.0	3.1E-09	2.2E-02
Copper	1.4E-02	1.0E-03	1.0	1.4E-08	1.0	1.4E-08	1.0E-01
Iron	9.4E-01	1.0E-03	1.0	9.4E-07	1.0	9.4E-07	6.7E+00
Lead	6.4E-02	1.0E-04	1.0	6.4E-09	1.0	6.4E-09	4.6E-02
Manganese (non-diet)	6.6E-01	1.0E-03	1.0	6.6E-07	1.0	6.6E-07	4.7E+00
Nickel	1.9E-02	2.0E-04	1.0	3.8E-09	1.0	3.8E-09	2.7E-02
Selenium	5.0E-04	1.0E-03	1.0	5.0E-10	1.0	5.0E-10	3.6E-03
Vanadium	2.2E-03	1.0E-03	1.0	2.2E-09	1.0	2.2E-09	1.6E-02
Zinc	6.7E+00	6.0E-04	1.0	4.0E-06	1.0	4.0E-06	2.9E+01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	2.5E-01	mg/kg/day	1.0E+00	mg/kg/day	2.5E-01
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	4.0E-04	mg/kg/day	2.1E-01
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	9.8E-03	mg/kg/day	2.0E-01	mg/kg/day	4.9E-02
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	2.0E-03	mg/kg/day	2.3E-02
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	2.7E-03	mg/kg/day	1.0E-03	mg/kg/day	2.7E+00
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	1.5E+00	mg/kg/day	8.4E-04
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	3.0E-04	mg/kg/day	1.1E+00
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	4.9E-03	mg/kg/day	4.0E-02	mg/kg/day	1.2E-01
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	6.2E-01	mg/kg/day	7.0E-01	mg/kg/day	8.9E-01
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	9.8E-02	mg/kg/day	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	5.7E-04	mg/kg/day	2.0E-03	mg/kg/day	2.8E-01
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	2.4E-02	mg/kg/day	6.1E-01
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	3.0E-04	mg/kg/day	3.7E-02
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	2.0E-02	mg/kg/day	3.3E-02
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.1E-02
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.4E-03
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	6.0E-01	mg/kg/day	2.8E-03
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	5.0E-03	mg/kg/day	3.3E-01
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	2.5E+00	mg/kg/day	3.0E-01	mg/kg/day	8.3E+00
			Exp. Route Total								NA					1.5E+01

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	3.0E-04	mg/kg/day	4.1E-02
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	4.2E-06	mg/kg/day	2.5E-05	mg/kg/day	1.7E-01
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					2.1E-01
		Exposure Point Total									NA					1.6E+01
	Exposure Medium Total										NA					1.6E+01
Medium Total											NA					1.6E+01

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	1.0E+00	mg/kg/day	2.2E-02
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	4.0E-04	mg/kg/day	1.7E-01
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	9.5E-05	mg/kg/day	3.0E-04	mg/kg/day	3.2E-01
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	2.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	5.0E-04	mg/kg/day	2.4E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	3.0E-03	mg/kg/day	2.8E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	2.4E-04	mg/kg/day	3.0E-04	mg/kg/day	8.0E-01
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	4.4E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	2.9E-02	mg/kg/day	7.0E-01	mg/kg/day	4.1E-02
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	2.4E-02	mg/kg/day	8.4E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	2.0E-02	mg/kg/day	2.9E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	3.1E-03
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	2.1E-01	mg/kg/day	3.0E-01	mg/kg/day	6.9E-01
			Exp. Route Total								NA					5.4E+00
			Dermal	Aluminum	7.18E-01	mg/L	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	2.20E-03	mg/L	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	6.0E-05	mg/kg/day	6.0E-02
				Arsenic	3.10E-03	mg/L	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	3.0E-04	mg/kg/day	1.7E-02
				Barium	7.10E-02	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.4E-02	mg/kg/day	8.3E-03
				Cadmium (water)	3.87E-02	mg/L	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.5E-05	mg/kg/day	2.5E+00
				Chromium (hexavalent)	2.76E-03	mg/L	NA	NA	NA	NA	NA	9.0E-06	mg/kg/day	7.5E-05	mg/kg/day	1.2E-01
				Cobalt	7.80E-03	mg/L	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	3.0E-04	mg/kg/day	1.7E-02
				Copper	1.43E-02	mg/L	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	4.0E-02	mg/kg/day	5.8E-04
				Iron	9.40E-01	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	7.0E-01	mg/kg/day	2.2E-03
				Lead	6.36E-02	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.55E-01	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	9.6E-04	mg/kg/day	1.1E+00
				Nickel	1.88E-02	mg/L	NA	NA	NA	NA	NA	6.1E-06	mg/kg/day	8.0E-04	mg/kg/day	7.7E-03
				Selenium	5.00E-04	mg/L	NA	NA	NA	NA	NA	8.2E-07	mg/kg/day	5.0E-03	mg/kg/day	1.6E-04
				Vanadium	2.20E-03	mg/L	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	1.3E-04	mg/kg/day	2.8E-02
				Zinc	6.71E+00	mg/L	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	3.0E-01	mg/kg/day	2.2E-02
			Exp. Route Total								NA					3.9E+00
		Exposure Point Total									NA					9.3E+00

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	3.7E-02	mg/kg/day	1.0E+00	mg/kg/day	3.7E-02
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	4.0E-04	mg/kg/day	2.9E-01
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.4E-01
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	5.0E-04	mg/kg/day	4.0E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-03	mg/kg/day	4.8E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	3.0E-04	mg/kg/day	1.4E+00
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	7.4E-04	mg/kg/day	4.0E-02	mg/kg/day	1.9E-02
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	4.9E-02	mg/kg/day	7.0E-01	mg/kg/day	7.0E-02
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	3.4E-02	mg/kg/day	2.4E-02	mg/kg/day	1.4E+00
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	9.8E-04	mg/kg/day	2.0E-02	mg/kg/day	4.9E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	5.0E-03	mg/kg/day	5.2E-03
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-03	mg/kg/day	2.3E-02
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	3.5E-01	mg/kg/day	3.0E-01	mg/kg/day	1.2E+00
			Exp. Route Total								NA					9.1E+00
			Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.0E+00	mg/kg/day	1.6E-04
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	5.0E-07	mg/kg/day	6.0E-05	mg/kg/day	8.4E-03
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	7.1E-07	mg/kg/day	3.0E-04	mg/kg/day	2.4E-03
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	1.4E-02	mg/kg/day	1.2E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	8.9E-06	mg/kg/day	2.5E-05	mg/kg/day	3.5E-01
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	7.5E-05	mg/kg/day	1.7E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	7.1E-07	mg/kg/day	3.0E-04	mg/kg/day	2.4E-03
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	3.3E-06	mg/kg/day	4.0E-02	mg/kg/day	8.2E-05
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	7.0E-01	mg/kg/day	3.1E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	9.6E-04	mg/kg/day	1.6E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	8.6E-07	mg/kg/day	8.0E-04	mg/kg/day	1.1E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	5.0E-03	mg/kg/day	2.3E-05
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	5.0E-07	mg/kg/day	1.3E-04	mg/kg/day	3.9E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	9.2E-04	mg/kg/day	3.0E-01	mg/kg/day	3.1E-03
			Exp. Route Total								NA					5.5E-01
		Exposure Point Total									NA					9.6E+00

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	4.8E-02	mg/kg/day	1.0E+00	mg/kg/day	4.8E-02
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	4.0E-04	mg/kg/day	3.7E-01
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	2.1E-04	mg/kg/day	3.0E-04	mg/kg/day	6.9E-01
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	2.0E-01	mg/kg/day	2.4E-02
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	5.0E-04	mg/kg/day	5.2E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	3.0E-03	mg/kg/day	6.1E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	5.2E-04	mg/kg/day	3.0E-04	mg/kg/day	1.7E+00
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	9.5E-04	mg/kg/day	4.0E-02	mg/kg/day	2.4E-02
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	6.3E-02	mg/kg/day	7.0E-01	mg/kg/day	9.0E-02
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	4.2E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	4.4E-02	mg/kg/day	2.4E-02	mg/kg/day	1.8E+00
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	2.0E-02	mg/kg/day	6.3E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	5.0E-03	mg/kg/day	6.7E-03
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	5.0E-03	mg/kg/day	2.9E-02
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	4.5E-01	mg/kg/day	3.0E-01	mg/kg/day	1.5E+00
			Exp. Route Total								NA					1.2E+01
			Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	1.0E+00	mg/kg/day	3.0E-04
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	9.3E-07	mg/kg/day	6.0E-05	mg/kg/day	1.6E-02
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	3.0E-04	mg/kg/day	4.4E-03
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	1.4E-02	mg/kg/day	2.2E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.5E-05	mg/kg/day	6.6E-01
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	7.5E-05	mg/kg/day	3.1E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	3.0E-04	mg/kg/day	4.4E-03
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	6.1E-06	mg/kg/day	4.0E-02	mg/kg/day	1.5E-04
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	4.0E-04	mg/kg/day	7.0E-01	mg/kg/day	5.7E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	9.6E-04	mg/kg/day	2.9E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	8.0E-04	mg/kg/day	2.0E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	5.0E-03	mg/kg/day	4.2E-05
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	9.3E-07	mg/kg/day	1.3E-04	mg/kg/day	7.2E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	3.0E-01	mg/kg/day	5.7E-03
			Exp. Route Total								NA					1.0E+00
		Exposure Point Total									NA					1.3E+01

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	1.2E-01	mg/m^3	NA	NA	NA	NA	NA	5.0E-03	mg/m^3	5.0E-03	mg/m3	9.9E-01
				Antimony	3.7E-04	mg/m^3	NA	NA	NA	NA	NA	1.5E-05	mg/m^3	NA	NA	NA
				Arsenic	5.1E-04	mg/m^3	NA	NA	NA	NA	NA	2.1E-05	mg/m^3	1.5E-05	mg/m3	1.4E+00
				Barium	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	4.9E-04	mg/m^3	5.0E-04	mg/m3	9.8E-01
				Cadmium (water)	6.4E-03	mg/m^3	NA	NA	NA	NA	NA	2.7E-04	mg/m^3	1.0E-05	mg/m3	2.7E+01
				Chromium (hexavalent)	4.6E-04	mg/m^3	NA	NA	NA	NA	NA	1.9E-05	mg/m^3	8.0E-06	mg/m3	2.4E+00
				Cobalt	1.3E-03	mg/m^3	NA	NA	NA	NA	NA	5.4E-05	mg/m^3	6.0E-06	mg/m3	9.0E+00
				Copper	2.4E-03	mg/m^3	NA	NA	NA	NA	NA	9.9E-05	mg/m^3	NA	NA	NA
				Iron	1.6E-01	mg/m^3	NA	NA	NA	NA	NA	6.5E-03	mg/m^3	NA	NA	NA
				Lead	1.1E-02	mg/m^3	NA	NA	NA	NA	NA	4.4E-04	mg/m^3	NA	NA	NA
				Manganese (non-diet)	1.1E-01	mg/m^3	NA	NA	NA	NA	NA	4.5E-03	mg/m^3	5.0E-05	mg/m3	9.1E+01
				Nickel	3.1E-03	mg/m^3	NA	NA	NA	NA	NA	1.3E-04	mg/m^3	9.0E-05	mg/m3	1.4E+00
				Selenium	8.3E-05	mg/m^3	NA	NA	NA	NA	NA	3.5E-06	mg/m^3	2.0E-02	mg/m3	1.7E-04
				Vanadium	3.7E-04	mg/m^3	NA	NA	NA	NA	NA	1.5E-05	mg/m^3	1.0E-04	mg/m3	1.5E-01
				Zinc	1.1E+00	mg/m^3	NA	NA	NA	NA	NA	4.6E-02	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					1.3E+02
		Exposure Point Total									NA					1.3E+02
	Exposure Medium Total										NA					1.7E+02
Medium Total											NA					1.7E+02

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	1.0E+00	mg/kg/day	1.5E-02
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	9.5E-05	mg/kg/day	3.0E-04	mg/kg/day	3.2E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-01	mg/kg/day	3.7E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	2.0E-03	mg/kg/day	1.6E-02
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-03	mg/kg/day	2.0E-01
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.5E+00	mg/kg/day	9.1E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.7E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-02	mg/kg/day	4.2E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-02	mg/kg/day	7.0E-01	mg/kg/day	4.6E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	1.4E-01	mg/kg/day	1.8E-01
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E-04	mg/kg/day	1.2E+00
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	5.0E-03	mg/kg/day	4.9E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	7.9E-04	mg/kg/day	5.0E-03	mg/kg/day	1.6E-01
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	5.0E-03	mg/kg/day	1.1E-01
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	8.9E-02	mg/kg/day	3.0E-01	mg/kg/day	3.0E-01
			Exp. Route Total								NA					5.4E+00
		Exposure Point Total									NA					5.4E+00

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-01	mg/kg/day	1.0E+00	mg/kg/day	1.4E-01
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	3.0E-04	mg/kg/day	1.9E+00
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	2.0E-01	mg/kg/day	5.1E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	2.0E-03	mg/kg/day	1.9E-01
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	6.4E-04	mg/kg/day	1.0E-03	mg/kg/day	6.4E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	1.5E+00	mg/kg/day	3.6E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	3.0E-04	mg/kg/day	2.3E-01
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	4.0E-02	mg/kg/day	7.8E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-01	mg/kg/day	7.0E-01	mg/kg/day	2.4E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+00	mg/kg/day	1.4E-01	mg/kg/day	8.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.0E-04	mg/kg/day	1.2E-01
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.9E-02
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	5.0E-03	mg/kg/day	1.7E+00
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	5.0E-03	mg/kg/day	1.4E-01
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	3.0E-01	mg/kg/day	1.5E+00
			Exp. Route Total								NA					1.6E+01
		Exposure Point Total									NA					1.6E+01

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	1.0E+00	mg/kg/day	3.4E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.0E-03	mg/kg/day	8.0E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	1.0E-03	mg/kg/day	4.8E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	1.5E+00	mg/kg/day	2.4E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.2E-02
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	7.0E-01	mg/kg/day	9.4E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	1.4E-01	mg/kg/day	2.3E-02
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E-04	mg/kg/day	1.4E-01
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	2.0E-02	mg/kg/day	5.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	6.6E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	3.0E-01	mg/kg/day	7.2E-02
			Exp. Route Total								NA					6.5E-01
		Exposure Point Total									NA					6.5E-01

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	3.0E-04	mg/kg/day	3.0E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	2.0E-01	mg/kg/day	1.2E-03
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	9.2E-05	mg/kg/day	2.0E-03	mg/kg/day	4.6E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-03	mg/kg/day	1.1E-01
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	1.5E+00	mg/kg/day	4.9E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	4.0E-02	mg/kg/day	8.4E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.8E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.8E-04	mg/kg/day	1.4E-01	mg/kg/day	5.6E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.0E-04	mg/kg/day	1.3E+00
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	8.5E-04	mg/kg/day	2.0E-02	mg/kg/day	4.3E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	3.0E-01	mg/kg/day	3.5E-01
			Exp. Route Total								NA					4.6E+00
		Exposure Point Total									NA					4.6E+00
	Exposure Medium Total										NA					2.7E+01

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	1.7E+00	mg/kg/day	1.0E+00	mg/kg/day	1.7E+00
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-04	mg/kg/day	4.2E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	6.8E-04	mg/kg/day	3.0E-04	mg/kg/day	2.3E+00
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	9.2E-02	mg/kg/day	2.0E-01	mg/kg/day	4.6E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	2.0E-03	mg/kg/day	9.2E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	6.6E-02	mg/kg/day	1.0E-03	mg/kg/day	6.6E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	1.5E+00	mg/kg/day	7.8E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-02	mg/kg/day	3.0E-04	mg/kg/day	5.5E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-02	mg/kg/day	4.0E-02	mg/kg/day	2.1E+00
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+01	mg/kg/day	7.0E-01	mg/kg/day	3.9E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	1.3E+00	mg/kg/day	1.4E-01	mg/kg/day	9.5E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-04	mg/kg/day	2.0E+00
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-02	mg/kg/day	3.8E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	5.0E-03	mg/kg/day	2.2E+00
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	6.4E+00	mg/kg/day	3.0E-01	mg/kg/day	2.1E+01
			Exp. Route Total								NA					2.1E+02
		Exposure Point Total									NA					2.1E+02

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	2.5E-05	mg/kg/day	9.5E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.1E-02
		Exposure Point Total									NA					1.1E-02
	Exposure Medium Total										NA					2.1E+02
Medium Total											NA					2.3E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					4E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.1E+04	mg/kg	6.9E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.1E+01	mg/kg	4.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.6E-05	NA	NA	NA	NA	NA
				Barium	4.3E+02	mg/kg	2.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.2E+02	mg/kg	7.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.5E+01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	1.5E+01	mg/kg	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.1E+02	mg/kg	1.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.7E+04	mg/kg	1.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.3E+03	mg/kg	2.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	1.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.4E+02	mg/kg	4.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.9E-01	mg/kg	3.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.9E+01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	5.3E+02	mg/kg	3.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	5.3E-01	mg/kg	3.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	7.5E+01	mg/kg	4.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.0E+00	mg/kg	6.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	4.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.1E+05	mg/kg	7.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.6E-05					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.1E+01	mg/kg	8.6E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.3E-05	NA	NA	NA	NA	NA
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.2E+02	mg/kg	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.3E-05					NA
		Exposure Point Total									7.9E-05					NA
	Exposure Medium Total										7.9E-05					NA
Medium Total											7.9E-05					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	7.2E-01	mg/L	6.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	2.7E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.1E-05	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	6.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	2.4E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.5E-05	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	6.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	8.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	5.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	5.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	4.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	5.9E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.6E-05					NA
			Dermal	Aluminum	7.2E-01	mg/L	1.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	3.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	4.5E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-06	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	5.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	8.0E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	1.7E-04	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	4.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	2.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	1.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	9.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	9.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	5.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	7.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	3.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	5.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.8E-04					NA
		Exposure Point Total									2.5E-04					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	7.2E-01	mg/L	2.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	8.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	1.2E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.7E-04	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	2.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	1.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	1.0E-04	mg/kg/day	5.0E-01	1/(mg/kg/day)	6.1E-05	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	2.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	5.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	3.5E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	2.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	2.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	7.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	8.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	2.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.3E-04					NA
			Dermal	Aluminum	7.2E-01	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	4.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	6.3E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	9.4E-07	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	1.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	7.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	1.1E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.4E-05	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	6.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	7.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	1.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	4.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	8.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.5E-05					NA
		Exposure Point Total									2.6E-04					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	7.2E-01	mg/L	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	3.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	5.2E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	7.8E-05	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	6.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	4.7E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.7E-05	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	2.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	1.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	1.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	8.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	3.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	1.1E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.1E-04					NA
			Dermal	Aluminum	7.2E-01	mg/L	2.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	6.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	8.7E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.3E-06	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	2.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	1.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	1.6E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.6E-05	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	8.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	4.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	1.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	1.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	6.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	1.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.7E-05					NA
		Exposure Point Total									1.3E-04					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	1.2E-01	mg/m^3	4.8E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.7E-04	mg/m^3	1.5E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.1E-04	mg/m^3	2.1E-05	mg/m^3	4.3E-03	1/(µg/m3)	9.0E-05	NA	NA	NA	NA	NA
				Barium	1.2E-02	mg/m^3	4.8E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	6.4E-03	mg/m^3	2.6E-04	mg/m^3	1.8E-03	1/(µg/m3)	4.7E-04	NA	NA	NA	NA	NA
				Chromium (hexavalent)	4.6E-04	mg/m^3	1.9E-05	mg/m^3	8.4E-02	1/(µg/m3)	1.2E-03	NA	NA	NA	NA	NA
				Cobalt	1.3E-03	mg/m^3	5.2E-05	mg/m^3	9.0E-03	1/(µg/m3)	4.7E-04	NA	NA	NA	NA	NA
				Copper	2.4E-03	mg/m^3	9.6E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.6E-01	mg/m^3	6.3E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/m^3	4.3E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.1E-01	mg/m^3	4.4E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.1E-03	mg/m^3	1.3E-04	mg/m^3	2.6E-04	1/(µg/m3)	3.3E-05	NA	NA	NA	NA	NA
				Selenium	8.3E-05	mg/m^3	3.4E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.7E-04	mg/m^3	1.5E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.1E+00	mg/m^3	4.5E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.3E-03					NA
		Exposure Point Total									2.3E-03					NA
	Exposure Medium Total										2.9E-03					NA
Medium Total											2.9E-03					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	7.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.2E-02	mg/kg	4.5E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-05	NA	NA	NA	NA	NA
				Barium	2.5E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E-02	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.6E-02	mg/kg	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	6.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	4.7E-02	mg/kg	6.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.6E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.1E+01	mg/kg	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.6E-01	mg/kg	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.1E-02	mg/kg	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.2E-02	mg/kg	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-01	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.6E-01	mg/kg	3.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.9E-01	mg/kg	5.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.0E+01	mg/kg	4.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.8E-05					NA
		Exposure Point Total									6.8E-05					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	6.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.8E-01	mg/kg	2.8E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.1E-04	NA	NA	NA	NA	NA
				Barium	1.0E+02	mg/kg	4.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.4E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.4E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.8E-02	mg/kg	3.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	3.1E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+02	mg/kg	8.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.9E+00	mg/kg	9.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	5.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.2E-02	mg/kg	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.9E-01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.7E+00	mg/kg	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.3E+02	mg/kg	3.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	7.2E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+02	mg/kg	2.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.1E-04					NA
		Exposure Point Total									4.1E-04					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.5E-02	mg/kg	2.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.2E-05	NA	NA	NA	NA	NA
				Barium	4.5E+00	mg/kg	1.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E-02	mg/kg	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	5.9E-02	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.8E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	8.2E+00	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.7E-02	mg/kg	6.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.3E-01	mg/kg	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.3E-01	mg/kg	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.0E-01	mg/kg	7.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	5.7E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.7E+01	mg/kg	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.2E-05					NA
		Exposure Point Total									3.2E-05					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	5.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.1E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.9E-02	mg/kg	4.3E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.4E-05	NA	NA	NA	NA	NA
				Barium	1.1E-01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.0E-02	mg/kg	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	4.7E-02	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.2E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+01	mg/kg	4.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	5.1E-01	mg/kg	5.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	3.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.8E-02	mg/kg	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.7E-01	mg/kg	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	7.8E-01	mg/kg	8.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.6E-01	mg/kg	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+01	mg/kg	5.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-05					NA
		Exposure Point Total									6.4E-05					NA
	Exposure Medium Total										5.8E-04					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	8.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.5E-01	mg/kg	3.2E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-04	NA	NA	NA	NA	NA
				Barium	2.1E+01	mg/kg	4.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.1E-02	mg/kg	8.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+01	mg/kg	3.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.7E+00	mg/kg	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.7E+00	mg/kg	7.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.9E+01	mg/kg	4.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.1E+03	mg/kg	1.3E+01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	7.1E+01	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	6.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.5E-02	mg/kg	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.7E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.7E-01	mg/kg	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	5.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.4E+03	mg/kg	3.1E+00	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-04					NA
		Exposure Point Total									4.8E-04					NA

TABLE 7.3.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.1E-01	mg/kg	2.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.3E-07	NA	NA	NA	NA	NA
				Barium	2.0E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	2.1E+01	mg/kg	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.7E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.2E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.3E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.6E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.8E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.3E-07					NA
		Exposure Point Total									3.3E-07					NA
	Exposure Medium Total										4.9E-04					NA
Medium Total											1.1E-03					NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											4E-03					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.3.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
					Value	Units	Value				Units	Value				Units	Cancer Risk (3)
							0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs		0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)		
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	2.8E-03	mg/L	2.4E-06	4.9E-06	2.7E-06	2.7E-06	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	2.5E-05
			Dermal	Chromium (hexavalent)	2.8E-03	mg/L	2.6E-07	5.1E-07	1.1E-06	1.1E-06	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	1.7E-04
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	2.8E-03	mg/L	4.1E-06	8.2E-06	1.4E-05	1.4E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	6.1E-05
			Dermal	Chromium (hexavalent)	2.8E-03	mg/L	3.6E-08	7.2E-08	1.6E-07	1.6E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.4E-05
		Surface Water (Sweat Lodge)	Ingestion	Chromium (hexavalent)	2.8E-03	mg/L	n/a	1.1E-05	5.6E-06	5.6E-06	mg/kg-day	n/a	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	2.7E-05
			Dermal	Chromium (hexavalent)	2.8E-03	mg/L	n/a	1.3E-07	2.2E-07	2.2E-07	mg/kg-day	n/a	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.6E-05
		Water Vapor (Sweat Lodge)	Inhalation	Chromium (hexavalent)	4.6E-04	mg/m^3	n/a	1.1E-06	2.7E-06	2.7E-06	mg/m^3	n/a	2.5E-01	2.5E-01	8.4E-02	$1/(\mu g/m^3)$	1.2E-03

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
COPC = chemical of potential concern
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
$\mu g/m^3$= microgram per cubic meter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.1E+04	mg/kg	1.5E-02	mg/kg/day	NA	NA	NA	4.2E-02	mg/kg/day	1.0E+00	mg/kg/day	4.2E-02
				Antimony	3.6E+00	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	1.4E-05	mg/kg/day	4.0E-04	mg/kg/day	3.6E-02
				Arsenic	1.1E+01	mg/kg	9.6E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.4E-05	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	8.9E-02
				Barium	4.3E+02	mg/kg	6.0E-04	mg/kg/day	NA	NA	NA	1.7E-03	mg/kg/day	2.0E-01	mg/kg/day	8.4E-03
				Beryllium	2.0E+00	mg/kg	2.8E-06	mg/kg/day	NA	NA	NA	7.8E-06	mg/kg/day	2.0E-03	mg/kg/day	3.9E-03
				Cadmium (non-water)	1.2E+02	mg/kg	1.6E-04	mg/kg/day	NA	NA	NA	4.6E-04	mg/kg/day	1.0E-03	mg/kg/day	4.6E-01
				Chromium (trivalent)	5.5E+01	mg/kg	7.7E-05	mg/kg/day	NA	NA	NA	2.2E-04	mg/kg/day	1.5E+00	mg/kg/day	1.4E-04
				Cobalt	1.5E+01	mg/kg	2.1E-05	mg/kg/day	NA	NA	NA	5.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.9E-01
				Copper	2.1E+02	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	8.3E-04	mg/kg/day	4.0E-02	mg/kg/day	2.1E-02
				Iron	2.7E+04	mg/kg	3.8E-02	mg/kg/day	NA	NA	NA	1.1E-01	mg/kg/day	7.0E-01	mg/kg/day	1.5E-01
				Lead	4.3E+03	mg/kg	6.0E-03	mg/kg/day	NA	NA	NA	1.7E-02	mg/kg/day	NA	NA	NA
				Lithium	2.5E+01	mg/kg	3.5E-05	mg/kg/day	NA	NA	NA	9.8E-05	mg/kg/day	2.0E-03	mg/kg/day	4.9E-02
				Manganese (non-diet)	6.4E+02	mg/kg	8.9E-04	mg/kg/day	NA	NA	NA	2.5E-03	mg/kg/day	2.4E-02	mg/kg/day	1.0E-01
				Mercury (HgCl)	4.9E-01	mg/kg	6.9E-07	mg/kg/day	NA	NA	NA	1.9E-06	mg/kg/day	3.0E-04	mg/kg/day	6.4E-03
				Nickel	2.9E+01	mg/kg	4.1E-05	mg/kg/day	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	5.8E-03
				Phosphorus	5.3E+02	mg/kg	7.4E-04	mg/kg/day	NA	NA	NA	2.1E-03	mg/kg/day	NA	NA	NA
				Selenium	6.9E+00	mg/kg	9.6E-06	mg/kg/day	NA	NA	NA	2.7E-05	mg/kg/day	5.0E-03	mg/kg/day	5.4E-03
				Silver	5.3E-01	mg/kg	7.4E-07	mg/kg/day	NA	NA	NA	2.1E-06	mg/kg/day	5.0E-03	mg/kg/day	4.1E-04
				Strontium	7.5E+01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	2.9E-04	mg/kg/day	6.0E-01	mg/kg/day	4.9E-04
				Thallium	1.0E+00	mg/kg	1.4E-06	mg/kg/day	NA	NA	NA	3.9E-06	mg/kg/day	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	2.8E-04	mg/kg/day	5.0E-03	mg/kg/day	5.6E-02
				Zinc	1.1E+05	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	4.3E-01	mg/kg/day	3.0E-01	mg/kg/day	1.4E+00
			Exp. Route Total								1.4E-05					2.7E+00

TABLE 7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.1E+01	mg/kg	2.4E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.3E-05	6.6E-06	mg/kg/day	3.0E-04	mg/kg/day	2.2E-02
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.2E+02	mg/kg	8.0E-07	mg/kg/day	NA	NA	NA	2.2E-06	mg/kg/day	2.5E-05	mg/kg/day	9.0E-02
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								1.3E-05					1.1E-01
		Exposure Point Total									2.7E-05					2.8E+00
	Exposure Medium Total										2.7E-05					2.8E+00
Medium Total											2.7E-05					2.8E+00

TABLE 7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Ingestion	Aluminum	7.2E-01	mg/L	1.4E-03	mg/kg/day	NA	NA	NA	3.9E-03	mg/kg/day	1.0E+00	mg/kg/day	3.9E-03
				Antimony	2.2E-03	mg/L	4.2E-06	mg/kg/day	NA	NA	NA	1.2E-05	mg/kg/day	4.0E-04	mg/kg/day	3.0E-02
				Arsenic	3.1E-03	mg/L	6.0E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	9.0E-06	1.7E-05	mg/kg/day	3.0E-04	mg/kg/day	5.6E-02
				Barium	7.1E-02	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	3.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.9E-03
				Cadmium (water)	3.9E-02	mg/L	7.5E-05	mg/kg/day	NA	NA	NA	2.1E-04	mg/kg/day	5.0E-04	mg/kg/day	4.2E-01
				Chromium (hexavalent)	2.8E-03	mg/L	5.3E-06	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.7E-06	1.5E-05	mg/kg/day	3.0E-03	mg/kg/day	5.0E-03
				Cobalt	7.8E-03	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	4.2E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Copper	1.4E-02	mg/L	2.8E-05	mg/kg/day	NA	NA	NA	7.7E-05	mg/kg/day	4.0E-02	mg/kg/day	1.9E-03
				Iron	9.4E-01	mg/L	1.8E-03	mg/kg/day	NA	NA	NA	5.1E-03	mg/kg/day	7.0E-01	mg/kg/day	7.3E-03
				Lead	6.4E-02	mg/L	1.2E-04	mg/kg/day	NA	NA	NA	3.4E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	1.3E-03	mg/kg/day	NA	NA	NA	3.5E-03	mg/kg/day	2.4E-02	mg/kg/day	1.5E-01
				Nickel	1.9E-02	mg/L	3.6E-05	mg/kg/day	NA	NA	NA	1.0E-04	mg/kg/day	2.0E-02	mg/kg/day	5.1E-03
				Selenium	5.0E-04	mg/L	9.6E-07	mg/kg/day	NA	NA	NA	2.7E-06	mg/kg/day	5.0E-03	mg/kg/day	5.4E-04
				Vanadium	2.2E-03	mg/L	4.2E-06	mg/kg/day	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.4E-03
				Zinc	6.7E+00	mg/L	1.3E-02	mg/kg/day	NA	NA	NA	3.6E-02	mg/kg/day	3.0E-01	mg/kg/day	1.2E-01
			Exp. Route Total								1.2E-05					9.4E-01
			Dermal	Aluminum	7.2E-01	mg/L	3.0E-04	mg/kg/day	NA	NA	NA	8.3E-04	mg/kg/day	1.0E+00	mg/kg/day	8.3E-04
				Antimony	2.2E-03	mg/L	9.1E-07	mg/kg/day	NA	NA	NA	2.5E-06	mg/kg/day	6.0E-05	mg/kg/day	4.2E-02
				Arsenic	3.1E-03	mg/L	1.3E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.9E-06	3.6E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Barium	7.1E-02	mg/L	2.9E-05	mg/kg/day	NA	NA	NA	8.2E-05	mg/kg/day	1.4E-02	mg/kg/day	5.9E-03
				Cadmium (water)	3.9E-02	mg/L	1.6E-05	mg/kg/day	NA	NA	NA	4.5E-05	mg/kg/day	2.5E-05	mg/kg/day	1.8E+00
				Chromium (hexavalent)	2.8E-03	mg/L	2.3E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	4.5E-05	6.4E-06	mg/kg/day	7.5E-05	mg/kg/day	8.5E-02
				Cobalt	7.8E-03	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	3.6E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Copper	1.4E-02	mg/L	5.9E-06	mg/kg/day	NA	NA	NA	1.6E-05	mg/kg/day	4.0E-02	mg/kg/day	4.1E-04
				Iron	9.4E-01	mg/L	3.9E-04	mg/kg/day	NA	NA	NA	1.1E-03	mg/kg/day	7.0E-01	mg/kg/day	1.5E-03
				Lead	6.4E-02	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	7.3E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	2.7E-04	mg/kg/day	NA	NA	NA	7.6E-04	mg/kg/day	9.6E-04	mg/kg/day	7.9E-01
				Nickel	1.9E-02	mg/L	1.5E-06	mg/kg/day	NA	NA	NA	4.3E-06	mg/kg/day	8.0E-04	mg/kg/day	5.4E-03
				Selenium	5.0E-04	mg/L	2.1E-07	mg/kg/day	NA	NA	NA	5.8E-07	mg/kg/day	5.0E-03	mg/kg/day	1.2E-04
				Vanadium	2.2E-03	mg/L	9.1E-07	mg/kg/day	NA	NA	NA	2.5E-06	mg/kg/day	1.3E-04	mg/kg/day	2.0E-02
				Zinc	6.7E+00	mg/L	1.7E-03	mg/kg/day	NA	NA	NA	4.6E-03	mg/kg/day	3.0E-01	mg/kg/day	1.5E-02
			Exp. Route Total								4.7E-05					2.8E+00
		Exposure Point Total									5.9E-05					3.7E+00
	Exposure Medium Total										5.9E-05					3.7E+00

TABLE 7.4.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Medium Total											5.9E-05					3.7E+00
Receptor Total (Sediment + Surface Water)											9E-05					6E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.4.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Exposure Scenario: Work Activities

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)
Aluminum	7.2E-01	1.0E-03	6.0	4.3E-06
Antimony	2.2E-03	1.0E-03	6.0	1.3E-08
Arsenic	3.1E-03	1.0E-03	6.0	1.9E-08
Barium	7.1E-02	1.0E-03	6.0	4.3E-07
Cadmium (water)	3.9E-02	1.0E-03	6.0	2.3E-07
Chromium (hexavalent)	2.8E-03	2.0E-03	6.0	3.3E-08
Cobalt	7.8E-03	4.0E-04	6.0	1.9E-08
Copper	1.4E-02	1.0E-03	6.0	8.6E-08
Iron	9.4E-01	1.0E-03	6.0	5.6E-06
Lead	6.4E-02	1.0E-04	6.0	3.8E-08
Manganese (non-diet)	6.6E-01	1.0E-03	6.0	3.9E-06
Nickel	1.9E-02	2.0E-04	6.0	2.3E-08
Selenium	5.0E-04	1.0E-03	6.0	3.0E-09
Vanadium	2.2E-03	1.0E-03	6.0	1.3E-08
Zinc	6.7E+00	6.0E-04	6.0	2.4E-05

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event =milligram per square centimeter per event
mg/L = milligram per liter

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	1.0E+00	mg/kg/day	1.0E-03
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	3.5E-07	mg/kg/day	4.0E-04	mg/kg/day	8.7E-04
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	6.6E-07	mg/kg/day	3.0E-04	mg/kg/day	2.2E-03
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	2.0E-01	mg/kg/day	2.1E-04
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	2.0E-03	mg/kg/day	9.6E-05
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	1.0E-03	mg/kg/day	1.1E-02
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	5.3E-06	mg/kg/day	1.5E+00	mg/kg/day	3.5E-06
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	3.0E-04	mg/kg/day	4.8E-03
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	4.0E-02	mg/kg/day	5.1E-04
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	7.0E-01	mg/kg/day	3.7E-03
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	2.0E-03	mg/kg/day	1.2E-03
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	6.1E-05	mg/kg/day	2.4E-02	mg/kg/day	2.5E-03
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	4.7E-08	mg/kg/day	3.0E-04	mg/kg/day	1.6E-04
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	2.0E-02	mg/kg/day	1.4E-04
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	5.1E-05	mg/kg/day	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-07	mg/kg/day	5.0E-03	mg/kg/day	1.3E-04
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-08	mg/kg/day	5.0E-03	mg/kg/day	1.0E-05
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	7.2E-06	mg/kg/day	6.0E-01	mg/kg/day	1.2E-05
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	9.6E-08	mg/kg/day	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	5.0E-03	mg/kg/day	1.4E-03
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	1.0E-02	mg/kg/day	3.0E-01	mg/kg/day	3.5E-02
			Exp. Route Total								NA					6.5E-02

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	3.0E-04	mg/kg/day	4.6E-04
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	4.7E-08	mg/kg/day	2.5E-05	mg/kg/day	1.9E-03
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					2.4E-03
		Exposure Point Total									NA					6.7E-02
	Exposure Medium Total										NA					6.7E-02
Medium Total											NA					6.7E-02

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	1.0E+00	mg/kg/day	6.3E-05
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	4.0E-04	mg/kg/day	4.9E-04
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	2.7E-07	mg/kg/day	3.0E-04	mg/kg/day	9.1E-04
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	6.3E-06	mg/kg/day	2.0E-01	mg/kg/day	3.1E-05
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	3.4E-06	mg/kg/day	5.0E-04	mg/kg/day	6.8E-03
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	3.0E-03	mg/kg/day	8.1E-05
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	6.9E-07	mg/kg/day	3.0E-04	mg/kg/day	2.3E-03
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	4.0E-02	mg/kg/day	3.2E-05
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	7.0E-01	mg/kg/day	1.2E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	5.6E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	5.8E-05	mg/kg/day	2.4E-02	mg/kg/day	2.4E-03
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	2.0E-02	mg/kg/day	8.3E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	4.4E-08	mg/kg/day	5.0E-03	mg/kg/day	8.8E-06
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	5.0E-03	mg/kg/day	3.9E-05
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	3.0E-01	mg/kg/day	2.0E-03
			Exp. Route Total								NA					1.5E-02
			Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E+00	mg/kg/day	1.4E-05
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.1E-08	mg/kg/day	6.0E-05	mg/kg/day	6.9E-04
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	5.8E-08	mg/kg/day	3.0E-04	mg/kg/day	1.9E-04
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	1.4E-02	mg/kg/day	9.6E-05
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	7.3E-07	mg/kg/day	2.5E-05	mg/kg/day	2.9E-02
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	7.5E-05	mg/kg/day	1.4E-03
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	5.9E-08	mg/kg/day	3.0E-04	mg/kg/day	2.0E-04
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	2.7E-07	mg/kg/day	4.0E-02	mg/kg/day	6.7E-06
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	7.0E-01	mg/kg/day	2.5E-05
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	9.6E-04	mg/kg/day	1.3E-02
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	7.1E-08	mg/kg/day	8.0E-04	mg/kg/day	8.9E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	9.4E-09	mg/kg/day	5.0E-03	mg/kg/day	1.9E-06
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.1E-08	mg/kg/day	1.3E-04	mg/kg/day	3.2E-04
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	7.6E-05	mg/kg/day	3.0E-01	mg/kg/day	2.5E-04
			Exp. Route Total								NA					4.5E-02
		Exposure Point Total									NA					6.1E-02

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	8.3E-06	mg/kg/day	1.0E+00	mg/kg/day	8.3E-06
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	2.5E-08	mg/kg/day	6.0E-05	mg/kg/day	4.2E-04
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	3.6E-08	mg/kg/day	3.0E-04	mg/kg/day	1.2E-04
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	8.2E-07	mg/kg/day	1.4E-02	mg/kg/day	5.9E-05
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	4.5E-07	mg/kg/day	2.5E-05	mg/kg/day	1.8E-02
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	6.4E-08	mg/kg/day	7.5E-05	mg/kg/day	8.5E-04
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	3.6E-08	mg/kg/day	3.0E-04	mg/kg/day	1.2E-04
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	4.0E-02	mg/kg/day	4.1E-06
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	7.0E-01	mg/kg/day	1.6E-05
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	7.4E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	7.6E-06	mg/kg/day	9.6E-04	mg/kg/day	7.9E-03
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	4.3E-08	mg/kg/day	8.0E-04	mg/kg/day	5.4E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	5.8E-09	mg/kg/day	5.0E-03	mg/kg/day	1.2E-06
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	2.5E-08	mg/kg/day	1.3E-04	mg/kg/day	2.0E-04
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	4.7E-05	mg/kg/day	3.0E-01	mg/kg/day	1.6E-04
			Exp. Route Total								NA					2.8E-02
		Exposure Point Total									NA					2.8E-02

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	1.0E+00	mg/kg/day	2.2E-02
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.6E-05	mg/kg/day	4.0E-04	mg/kg/day	1.6E-01
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	9.3E-05	mg/kg/day	3.0E-04	mg/kg/day	3.1E-01
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	2.1E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	5.0E-04	mg/kg/day	2.3E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	3.0E-03	mg/kg/day	2.8E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	3.0E-04	mg/kg/day	7.8E-01
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	4.3E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	7.0E-01	mg/kg/day	4.0E-02
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	2.4E-02	mg/kg/day	8.2E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	5.6E-04	mg/kg/day	2.0E-02	mg/kg/day	2.8E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	3.0E-03
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.6E-05	mg/kg/day	5.0E-03	mg/kg/day	1.3E-02
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	3.0E-01	mg/kg/day	6.7E-01
			Exp. Route Total								NA					5.2E+00

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E+00	mg/kg/day	1.2E-04
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.7E-07	mg/kg/day	6.0E-05	mg/kg/day	6.1E-03
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	3.0E-04	mg/kg/day	1.7E-03
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.4E-02	mg/kg/day	8.5E-04
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	6.5E-06	mg/kg/day	2.5E-05	mg/kg/day	2.6E-01
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	9.2E-07	mg/kg/day	7.5E-05	mg/kg/day	1.2E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	3.0E-04	mg/kg/day	1.7E-03
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	4.0E-02	mg/kg/day	6.0E-05
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	7.0E-01	mg/kg/day	2.2E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	9.6E-04	mg/kg/day	1.1E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	6.3E-07	mg/kg/day	8.0E-04	mg/kg/day	7.9E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	8.4E-08	mg/kg/day	5.0E-03	mg/kg/day	1.7E-05
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.7E-07	mg/kg/day	1.3E-04	mg/kg/day	2.8E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	3.0E-01	mg/kg/day	2.2E-03
			Exp. Route Total								NA					4.0E-01
		Exposure Point Total									NA					5.6E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					5.7E+00
	Exposure Medium Total (Wading + Potable Use)										NA					5.6E+00
Medium Total (Swimming + Potable Use)											NA					5.7E+00
Medium Total (Wading + Potable Use)											NA					5.6E+00

TABLE 7.5.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-04	mg/kg/day	5.1E-01
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.1E-02
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	9.9E-06	mg/kg/day	2.0E-03	mg/kg/day	4.9E-03
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.0E-03	mg/kg/day	3.1E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	1.9E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	7.0E-01	mg/kg/day	4.5E-03
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	1.4E-01	mg/kg/day	1.2E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	1.0E-04	mg/kg/day	4.2E-01
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.6E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	3.0E-01	mg/kg/day	2.9E-02
			Exp. Route Total								NA					1.5E+00
		Exposure Point Total									NA					1.5E+00
	Exposure Medium Total										NA					1.5E+00
Medium Total											NA					1.5E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					7E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					7E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.5.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	7.2E-01	1.0E-03	1.0	7.2E-07	1.0	7.2E-07	1.5E-01
Antimony	2.2E-03	1.0E-03	1.0	2.2E-09	1.0	2.2E-09	4.6E-04
Arsenic	3.1E-03	1.0E-03	1.0	3.1E-09	1.0	3.1E-09	6.5E-04
Barium	7.1E-02	1.0E-03	1.0	7.1E-08	1.0	7.1E-08	1.5E-02
Cadmium (water)	3.9E-02	1.0E-03	1.0	3.9E-08	1.0	3.9E-08	8.1E-03
Chromium (hexavalent)	2.8E-03	2.0E-03	1.0	5.5E-09	1.0	5.5E-09	1.2E-03
Cobalt	7.8E-03	4.0E-04	1.0	3.1E-09	1.0	3.1E-09	6.5E-04
Copper	1.4E-02	1.0E-03	1.0	1.4E-08	1.0	1.4E-08	3.0E-03
Iron	9.4E-01	1.0E-03	1.0	9.4E-07	1.0	9.4E-07	2.0E-01
Lead	6.4E-02	1.0E-04	1.0	6.4E-09	1.0	6.4E-09	1.3E-03
Manganese (non-diet)	6.6E-01	1.0E-03	1.0	6.6E-07	1.0	6.6E-07	1.4E-01
Nickel	1.9E-02	2.0E-04	1.0	3.8E-09	1.0	3.8E-09	7.9E-04
Selenium	5.0E-04	1.0E-03	1.0	5.0E-10	1.0	5.0E-10	1.0E-04
Vanadium	2.2E-03	1.0E-03	1.0	2.2E-09	1.0	2.2E-09	4.6E-04
Zinc	6.7E+00	6.0E-04	1.0	4.0E-06	1.0	4.0E-06	8.4E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.5.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Wading

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	6,032	2,373
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	7.2E-01	1.0E-03	2.0	1.4E-06	2.0	1.4E-06	9.9E-02
Antimony	2.2E-03	1.0E-03	2.0	4.4E-09	2.0	4.4E-09	3.0E-04
Arsenic	3.1E-03	1.0E-03	2.0	6.2E-09	2.0	6.2E-09	4.3E-04
Barium	7.1E-02	1.0E-03	2.0	1.4E-07	2.0	1.4E-07	9.8E-03
Cadmium (water)	3.9E-02	1.0E-03	2.0	7.7E-08	2.0	7.7E-08	5.3E-03
Chromium (hexavalent)	2.8E-03	2.0E-03	2.0	1.1E-08	2.0	1.1E-08	7.6E-04
Cobalt	7.8E-03	4.0E-04	2.0	6.2E-09	2.0	6.2E-09	4.3E-04
Copper	1.4E-02	1.0E-03	2.0	2.9E-08	2.0	2.9E-08	2.0E-03
Iron	9.4E-01	1.0E-03	2.0	1.9E-06	2.0	1.9E-06	1.3E-01
Lead	6.4E-02	1.0E-04	2.0	1.3E-08	2.0	1.3E-08	8.8E-04
Manganese (non-diet)	6.6E-01	1.0E-03	2.0	1.3E-06	2.0	1.3E-06	9.0E-02
Nickel	1.9E-02	2.0E-04	2.0	7.5E-09	2.0	7.5E-09	5.2E-04
Selenium	5.0E-04	1.0E-03	2.0	1.0E-09	2.0	1.0E-09	6.9E-05
Vanadium	2.2E-03	1.0E-03	2.0	4.4E-09	2.0	4.4E-09	3.0E-04
Zinc	6.7E+00	6.0E-04	2.0	8.1E-06	2.0	8.1E-06	5.5E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.5.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	350	350
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	7.2E-01	1.0E-03	0.71	5.1E-07	0.54	3.9E-07	1.2E+00
Antimony	2.2E-03	1.0E-03	0.71	1.6E-09	0.54	1.2E-09	3.7E-03
Arsenic	3.1E-03	1.0E-03	0.71	2.2E-09	0.54	1.7E-09	5.3E-03
Barium	7.1E-02	1.0E-03	0.71	5.0E-08	0.54	3.8E-08	1.2E-01
Cadmium (water)	3.9E-02	1.0E-03	0.71	2.7E-08	0.54	2.1E-08	6.6E-02
Chromium (hexavalent)	2.8E-03	2.0E-03	0.71	3.9E-09	0.54	3.0E-09	9.4E-03
Cobalt	7.8E-03	4.0E-04	0.71	2.2E-09	0.54	1.7E-09	5.3E-03
Copper	1.4E-02	1.0E-03	0.71	1.0E-08	0.54	7.7E-09	2.4E-02
Iron	9.4E-01	1.0E-03	0.71	6.7E-07	0.54	5.1E-07	1.6E+00
Lead	6.4E-02	1.0E-04	0.71	4.5E-09	0.54	3.4E-09	1.1E-02
Manganese (non-diet)	6.6E-01	1.0E-03	0.71	4.7E-07	0.54	3.5E-07	1.1E+00
Nickel	1.9E-02	2.0E-04	0.71	2.7E-09	0.54	2.0E-09	6.4E-03
Selenium	5.0E-04	1.0E-03	0.71	3.6E-10	0.54	2.7E-10	8.5E-04
Vanadium	2.2E-03	1.0E-03	0.71	1.6E-09	0.54	1.2E-09	3.7E-03
Zinc	6.7E+00	6.0E-04	0.71	2.9E-06	0.54	2.2E-06	6.9E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-06	mg/kg/day	4.0E-04	mg/kg/day	9.3E-03
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	7.0E-06	mg/kg/day	3.0E-04	mg/kg/day	2.3E-02
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	4.4E-04	mg/kg/day	2.0E-01	mg/kg/day	2.2E-03
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	2.0E-06	mg/kg/day	2.0E-03	mg/kg/day	1.0E-03
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E-03	mg/kg/day	1.2E-01
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	5.6E-05	mg/kg/day	1.5E+00	mg/kg/day	3.8E-05
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	3.0E-04	mg/kg/day	5.1E-02
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	4.0E-02	mg/kg/day	5.5E-03
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	7.0E-01	mg/kg/day	4.0E-02
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	6.5E-04	mg/kg/day	2.4E-02	mg/kg/day	2.7E-02
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.7E-03
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	2.0E-02	mg/kg/day	1.5E-03
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	7.0E-06	mg/kg/day	5.0E-03	mg/kg/day	1.4E-03
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-07	mg/kg/day	5.0E-03	mg/kg/day	1.1E-04
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	7.7E-05	mg/kg/day	6.0E-01	mg/kg/day	1.3E-04
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	7.4E-05	mg/kg/day	5.0E-03	mg/kg/day	1.5E-02
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	3.0E-01	mg/kg/day	3.7E-01
			Exp. Route Total								NA					6.9E-01

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.1E+01	mg/kg	NA	NA	NA	NA	NA	8.3E-07	mg/kg/day	3.0E-04	mg/kg/day	2.8E-03
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.2E+02	mg/kg	NA	NA	NA	NA	NA	2.8E-07	mg/kg/day	2.5E-05	mg/kg/day	1.1E-02
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.4E-02
		Exposure Point Total									NA					7.1E-01
	Exposure Medium Total										NA					7.1E-01
Medium Total											NA					7.1E-01

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	4.4E-04	mg/kg/day	1.0E+00	mg/kg/day	4.4E-04
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	4.0E-04	mg/kg/day	3.4E-03
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	1.9E-06	mg/kg/day	3.0E-04	mg/kg/day	6.3E-03
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	2.0E-01	mg/kg/day	2.2E-04
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	5.0E-04	mg/kg/day	4.8E-02
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	3.0E-03	mg/kg/day	5.6E-04
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	4.8E-06	mg/kg/day	3.0E-04	mg/kg/day	1.6E-02
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	8.8E-06	mg/kg/day	4.0E-02	mg/kg/day	2.2E-04
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	7.0E-01	mg/kg/day	8.2E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	4.0E-04	mg/kg/day	2.4E-02	mg/kg/day	1.7E-02
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	2.0E-02	mg/kg/day	5.8E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	3.1E-07	mg/kg/day	5.0E-03	mg/kg/day	6.1E-05
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	5.0E-03	mg/kg/day	2.7E-04
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	4.1E-03	mg/kg/day	3.0E-01	mg/kg/day	1.4E-02
			Exp. Route Total								NA					1.1E-01
			Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	1.0E+00	mg/kg/day	2.3E-05
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	7.2E-08	mg/kg/day	6.0E-05	mg/kg/day	1.2E-03
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	3.0E-04	mg/kg/day	3.4E-04
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	1.4E-02	mg/kg/day	1.7E-04
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	2.5E-05	mg/kg/day	5.0E-02
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	7.5E-05	mg/kg/day	2.4E-03
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	3.0E-04	mg/kg/day	3.4E-04
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	4.7E-07	mg/kg/day	4.0E-02	mg/kg/day	1.2E-05
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	7.0E-01	mg/kg/day	4.4E-05
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	9.6E-04	mg/kg/day	2.2E-02
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	8.0E-04	mg/kg/day	1.5E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.6E-08	mg/kg/day	5.0E-03	mg/kg/day	3.3E-06
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	7.2E-08	mg/kg/day	1.3E-04	mg/kg/day	5.5E-04
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-01	mg/kg/day	4.4E-04
			Exp. Route Total								NA					7.8E-02
		Exposure Point Total									NA					1.9E-01

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	1.0E+00	mg/kg/day	1.7E-05
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	5.3E-08	mg/kg/day	6.0E-05	mg/kg/day	8.9E-04
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	7.5E-08	mg/kg/day	3.0E-04	mg/kg/day	2.5E-04
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	1.4E-02	mg/kg/day	1.2E-04
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	9.4E-07	mg/kg/day	2.5E-05	mg/kg/day	3.8E-02
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	7.5E-05	mg/kg/day	1.8E-03
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	7.6E-08	mg/kg/day	3.0E-04	mg/kg/day	2.5E-04
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	3.5E-07	mg/kg/day	4.0E-02	mg/kg/day	8.7E-06
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	7.0E-01	mg/kg/day	3.3E-05
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	9.6E-04	mg/kg/day	1.7E-02
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	9.1E-08	mg/kg/day	8.0E-04	mg/kg/day	1.1E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.2E-08	mg/kg/day	5.0E-03	mg/kg/day	2.4E-06
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	5.3E-08	mg/kg/day	1.3E-04	mg/kg/day	4.1E-04
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	9.8E-05	mg/kg/day	3.0E-01	mg/kg/day	3.3E-04
			Exp. Route Total								NA					5.8E-02
		Exposure Point Total									NA					5.8E-02
		Surface Water (Potable Use)	Ingestion	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	3.6E-02	mg/kg/day	1.0E+00	mg/kg/day	3.6E-02
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	4.0E-04	mg/kg/day	2.7E-01
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	3.5E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	5.0E-04	mg/kg/day	3.9E+00
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-03	mg/kg/day	4.6E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	3.0E-04	mg/kg/day	1.3E+00
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	4.7E-02	mg/kg/day	7.0E-01	mg/kg/day	6.7E-02
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	3.3E-02	mg/kg/day	2.4E-02	mg/kg/day	1.4E+00
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	9.4E-04	mg/kg/day	2.0E-02	mg/kg/day	4.7E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	5.0E-03	mg/kg/day	5.0E-03
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-03	mg/kg/day	2.2E-02
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	3.3E-01	mg/kg/day	3.0E-01	mg/kg/day	1.1E+00
			Exp. Route Total								NA					8.7E+00

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	7.2E-01	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.0E+00	mg/kg/day	1.6E-04
				Antimony	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.8E-07	mg/kg/day	6.0E-05	mg/kg/day	8.1E-03
				Arsenic	3.1E-03	mg/L	NA	NA	NA	NA	NA	6.8E-07	mg/kg/day	3.0E-04	mg/kg/day	2.3E-03
				Barium	7.1E-02	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	1.4E-02	mg/kg/day	1.1E-03
				Cadmium (water)	3.9E-02	mg/L	NA	NA	NA	NA	NA	8.5E-06	mg/kg/day	2.5E-05	mg/kg/day	3.4E-01
				Chromium (hexavalent)	2.8E-03	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	7.5E-05	mg/kg/day	1.6E-02
				Cobalt	7.8E-03	mg/L	NA	NA	NA	NA	NA	6.9E-07	mg/kg/day	3.0E-04	mg/kg/day	2.3E-03
				Copper	1.4E-02	mg/L	NA	NA	NA	NA	NA	3.1E-06	mg/kg/day	4.0E-02	mg/kg/day	7.9E-05
				Iron	9.4E-01	mg/L	NA	NA	NA	NA	NA	2.1E-04	mg/kg/day	7.0E-01	mg/kg/day	3.0E-04
				Lead	6.4E-02	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	9.6E-04	mg/kg/day	1.5E-01
				Nickel	1.9E-02	mg/L	NA	NA	NA	NA	NA	8.3E-07	mg/kg/day	8.0E-04	mg/kg/day	1.0E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	5.0E-03	mg/kg/day	2.2E-05
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.8E-07	mg/kg/day	1.3E-04	mg/kg/day	3.7E-03
				Zinc	6.7E+00	mg/L	NA	NA	NA	NA	NA	8.8E-04	mg/kg/day	3.0E-01	mg/kg/day	2.9E-03
			Exp. Route Total								NA					5.3E-01
		Exposure Point Total									NA					9.2E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					9.4E+00
	Exposure Medium Total (Wading + Potable Use)										NA					9.3E+00
Medium Total (Swimming + Potable Use)											NA					9.4E+00
Medium Total (Wading + Potable Use)											NA					9.3E+00

TABLE 7.6.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	1.0E+00	mg/kg/day	3.1E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	4.0E-04	mg/kg/day	1.4E+00
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	7.4E-04	mg/kg/day	2.0E-01	mg/kg/day	3.7E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	1.0E-03	mg/kg/day	8.3E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	1.5E+00	mg/kg/day	5.0E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	4.0E-02	mg/kg/day	2.8E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	8.4E-03	mg/kg/day	7.0E-01	mg/kg/day	1.2E-02
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	1.4E-01	mg/kg/day	3.1E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-04	mg/kg/day	1.1E+00
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.4E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	5.0E-03	mg/kg/day	7.0E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	3.0E-01	mg/kg/day	7.8E-02
			Exp. Route Total								NA					3.9E+00
		Exposure Point Total									NA					3.9E+00
	Exposure Medium Total										NA					3.9E+00
Medium Total											NA					3.9E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					1E+01
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					1E+01

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.7.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.1E+04	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	4.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.1E+01	mg/kg	7.9E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.2E-06	NA	NA	NA	NA	NA
				Barium	4.3E+02	mg/kg	4.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	2.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.2E+02	mg/kg	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.5E+01	mg/kg	6.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	1.5E+01	mg/kg	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.1E+02	mg/kg	2.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.7E+04	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.3E+03	mg/kg	4.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.4E+02	mg/kg	7.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.9E-01	mg/kg	5.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.9E+01	mg/kg	3.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	5.3E+02	mg/kg	6.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	7.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	5.3E-01	mg/kg	6.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	7.5E+01	mg/kg	8.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.0E+00	mg/kg	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	8.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.1E+05	mg/kg	1.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.2E-06					NA

TABLE 7.7.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.1E+01	mg/kg	1.1E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.7E-07	NA	NA	NA	NA	NA
				Barium	4.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.2E+02	mg/kg	3.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.4E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.9E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	5.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	5.3E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	7.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.1E+05	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.7E-07					NA
		Exposure Point Total									1.3E-06					NA
	Exposure Medium Total										1.3E-06					NA
Medium Total											1.3E-06					NA

TABLE 7.7.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	7.2E-01	mg/L	5.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	2.4E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.6E-07	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	5.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	3.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	2.1E-07	mg/kg/day	5.0E-01	1/(mg/kg/day)	4.6E-07	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	6.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	7.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	5.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	1.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	3.9E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								8.2E-07					NA
			Dermal	Aluminum	7.2E-01	mg/L	5.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	1.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	2.5E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.8E-08	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	5.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	3.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	4.5E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.8E-06	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	2.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	1.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	7.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	5.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	5.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	3.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	4.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.9E-06					NA
		Exposure Point Total									3.7E-06					NA

TABLE 7.7.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	7.2E-01	mg/L	3.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	1.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	1.7E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.5E-08	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	3.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	2.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	3.0E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.0E-06	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	1.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	7.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	3.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	3.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	2.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	2.7E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.0E-06					NA
		Exposure Point Total									2.0E-06					NA
		Surface Water (Potable Use)	Ingestion	Aluminum	7.2E-01	mg/L	9.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	2.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	4.0E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.0E-05	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	9.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	5.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	3.5E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	5.5E-05	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	8.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	8.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	2.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	6.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	2.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	8.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.1E-04					NA

TABLE 7.7.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	7.2E-01	mg/L	4.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.2E-03	mg/L	1.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.1E-03	mg/L	2.1E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.1E-07	NA	NA	NA	NA	NA
				Barium	7.1E-02	mg/L	4.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.9E-02	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.8E-03	mg/L	3.7E-07	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.3E-05	NA	NA	NA	NA	NA
				Cobalt	7.8E-03	mg/L	2.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.4E-02	mg/L	9.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.4E-01	mg/L	6.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.4E-02	mg/L	4.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	6.6E-01	mg/L	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E-02	mg/L	2.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	3.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.7E+00	mg/L	2.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.3E-05					NA
		Exposure Point Total									1.4E-04					NA
	Exposure Medium Total (Swimming + Potable Use)										1.4E-04					NA
	Exposure Medium Total (Wading + Potable Use)										1.4E-04					NA
Medium Total (Swimming + Potable Use)											1.4E-04					NA
Medium Total (Wading + Potable Use)											1.4E-04					NA

TABLE 7.7.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	5.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.3E-02	mg/kg	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	NA	NA	NA	NA	NA
				Barium	3.3E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E-02	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.7E-02	mg/kg	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.4E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.0E-02	mg/kg	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.0E-01	mg/kg	4.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	8.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.0E-02	mg/kg	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	7.6E-02	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.0E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.6E-01	mg/kg	6.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	6.9E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.0E+01	mg/kg	4.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.1E-05					NA
		Exposure Point Total									2.1E-05					NA
	Exposure Medium Total										2.1E-05					NA
Medium Total											2.1E-05					NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)											2E-04					NA
Receptor Total (Sediment + Wading + Potable Use + Fish)											2E-04					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.7.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
							Value					Value					
					Value	Units	0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs	Units	0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)	Units	Cancer Risk (3)
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	2.8E-03	mg/L	4.8E-08	9.7E-08	3.5E-08	3.5E-08	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	4.6E-07
			Dermal	Chromium (hexavalent)	2.8E-03	mg/L	5.1E-09	1.0E-08	1.5E-08	1.5E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.8E-06
		Surface Water (Rivers & Creeks) Wading	Dermal	Chromium (hexavalent)	2.8E-03	mg/L	3.8E-09	7.7E-09	9.1E-09	9.1E-09	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.0E-06
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	2.8E-03	mg/L	3.9E-06	7.9E-06	1.2E-05	1.2E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	5.5E-05
			Dermal	Chromium (hexavalent)	2.8E-03	mg/L	4.6E-08	9.1E-08	1.0E-07	1.0E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.3E-05

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	6.7E-02	mg/kg/day	1.0E+00	mg/kg/day	6.7E-02
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	4.0E-04	mg/kg/day	8.9E-01
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-04	mg/kg/day	4.5E-01
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	8.2E-04	mg/kg/day	2.0E-01	mg/kg/day	4.1E-03
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	6.0E-06	mg/kg/day	2.0E-03	mg/kg/day	3.0E-03
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	1.0E-03	mg/kg/day	1.7E+00
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.1E-04
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	3.0E-04	mg/kg/day	6.2E-01
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	7.0E-01	mg/kg/day	6.5E-01
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	5.3E-03	mg/kg/day	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	2.0E-03	mg/kg/day	9.9E-02
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	2.4E-02	mg/kg/day	1.8E-01
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	3.0E-04	mg/kg/day	3.8E-03
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	5.0E-03	mg/kg/day	9.8E-02
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	2.0E-02	mg/kg/day	1.2E-02
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	5.3E-03	mg/kg/day	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	5.0E-03	mg/kg/day	5.0E-03
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-06	mg/kg/day	5.0E-03	mg/kg/day	9.0E-04
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	4.3E-04	mg/kg/day	6.0E-01	mg/kg/day	7.2E-04
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	4.8E-06	mg/kg/day	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	5.0E-03	mg/kg/day	6.1E-02
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	3.0E-01	mg/kg/day	3.5E-01
			Exp. Route Total								NA					5.2E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	3.0E-04	mg/kg/day	1.1E-01
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	8.6E-06	mg/kg/day	2.5E-05	mg/kg/day	3.4E-01
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					4.5E-01
		Exposure Point Total									NA					5.7E+00
	Exposure Medium Total										NA					5.7E+00
Medium Total											NA					5.7E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	1.0E+00	mg/kg/day	3.2E-03
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	3.8E-06	mg/kg/day	4.0E-04	mg/kg/day	9.6E-03
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	3.0E-04	mg/kg/day	7.6E-01
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	2.0E-01	mg/kg/day	1.7E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	1.9E-06	mg/kg/day	2.0E-03	mg/kg/day	9.4E-04
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-04	mg/kg/day	2.2E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	3.0E-03	mg/kg/day	8.4E-03
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.1E-04	mg/kg/day	3.0E-04	mg/kg/day	7.1E-01
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	4.0E-02	mg/kg/day	1.0E-03
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	3.5E-01	mg/kg/day	7.0E-01	mg/kg/day	4.9E-01
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	2.4E-02	mg/kg/day	4.5E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	3.9E-07	mg/kg/day	3.0E-04	mg/kg/day	1.3E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	6.7E-05	mg/kg/day	5.0E-03	mg/kg/day	1.3E-02
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	2.0E-02	mg/kg/day	1.1E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	5.5E-06	mg/kg/day	5.0E-03	mg/kg/day	1.1E-03
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	5.0E-03	mg/kg/day	3.0E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	5.6E-05	mg/kg/day	5.0E-03	mg/kg/day	1.1E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	4.2E-02	mg/kg/day	3.0E-01	mg/kg/day	1.4E-01
			Exp. Route Total								NA					2.9E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	6.8E-04	mg/kg/day	1.0E+00	mg/kg/day	6.8E-04
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	8.2E-07	mg/kg/day	6.0E-05	mg/kg/day	1.4E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	4.9E-05	mg/kg/day	3.0E-04	mg/kg/day	1.6E-01
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	7.2E-05	mg/kg/day	1.4E-02	mg/kg/day	5.1E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	4.0E-07	mg/kg/day	1.4E-05	mg/kg/day	2.9E-02
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	2.5E-05	mg/kg/day	9.4E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	7.5E-05	mg/kg/day	1.4E-01
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	3.0E-04	mg/kg/day	6.1E-02
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	8.8E-06	mg/kg/day	4.0E-02	mg/kg/day	2.2E-04
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	7.4E-02	mg/kg/day	7.0E-01	mg/kg/day	1.1E-01
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	5.3E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	9.6E-04	mg/kg/day	2.4E+00
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	8.3E-08	mg/kg/day	2.1E-05	mg/kg/day	4.0E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	5.0E-03	mg/kg/day	2.9E-03
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	9.6E-05	mg/kg/day	8.0E-04	mg/kg/day	1.2E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	5.0E-03	mg/kg/day	2.3E-04
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	2.0E-04	mg/kg/day	9.7E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	3.3E-07	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.3E-04	mg/kg/day	9.1E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	5.4E-03	mg/kg/day	3.0E-01	mg/kg/day	1.8E-02
			Exp. Route Total								NA					4.1E+00
		Exposure Point Total									NA					7.1E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.7E-02	mg/kg/day	1.0E+00	mg/kg/day	1.7E-02
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	4.0E-04	mg/kg/day	5.1E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	3.0E-04	mg/kg/day	4.0E+00
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	2.0E-01	mg/kg/day	8.9E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	2.0E-03	mg/kg/day	5.0E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	5.0E-04	mg/kg/day	1.2E+00
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-03	mg/kg/day	4.5E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	3.0E-04	mg/kg/day	3.8E+00
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	4.0E-02	mg/kg/day	5.5E-03
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.8E+00	mg/kg/day	7.0E-01	mg/kg/day	2.6E+00
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	5.8E-02	mg/kg/day	2.4E-02	mg/kg/day	2.4E+00
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	2.1E-06	mg/kg/day	3.0E-04	mg/kg/day	6.9E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	5.0E-03	mg/kg/day	7.1E-02
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	2.0E-02	mg/kg/day	6.0E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	5.0E-03	mg/kg/day	5.8E-03
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	5.6E-01	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	8.0E-06	mg/kg/day	5.0E-03	mg/kg/day	1.6E-03
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	8.1E-06	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	5.0E-03	mg/kg/day	5.9E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	2.2E-01	mg/kg/day	3.0E-01	mg/kg/day	7.5E-01
			Exp. Route Total								NA					1.6E+01

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	9.4E-05	mg/kg/day	1.0E+00	mg/kg/day	9.4E-05
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	6.0E-05	mg/kg/day	1.9E-03
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	6.8E-06	mg/kg/day	3.0E-04	mg/kg/day	2.3E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	1.4E-02	mg/kg/day	7.1E-04
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	5.6E-08	mg/kg/day	1.4E-05	mg/kg/day	4.0E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	2.5E-05	mg/kg/day	1.3E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	7.5E-05	mg/kg/day	2.0E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.5E-06	mg/kg/day	3.0E-04	mg/kg/day	8.4E-03
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	4.0E-02	mg/kg/day	3.1E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.0E-02	mg/kg/day	7.0E-01	mg/kg/day	1.5E-02
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	7.3E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	9.6E-04	mg/kg/day	3.4E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.1E-08	mg/kg/day	2.1E-05	mg/kg/day	5.5E-04
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	2.0E-06	mg/kg/day	5.0E-03	mg/kg/day	4.0E-04
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	8.0E-04	mg/kg/day	1.7E-02
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	5.0E-03	mg/kg/day	3.2E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	2.7E-08	mg/kg/day	2.0E-04	mg/kg/day	1.3E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	4.5E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	1.3E-04	mg/kg/day	1.3E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	3.0E-01	mg/kg/day	2.5E-03
			Exp. Route Total								NA					5.7E-01
		Exposure Point Total									NA					1.6E+01

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	6.7E-03	mg/kg/day	1.0E+00	mg/kg/day	6.7E-03
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	8.1E-06	mg/kg/day	4.0E-04	mg/kg/day	2.0E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	4.8E-04	mg/kg/day	3.0E-04	mg/kg/day	1.6E+00
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	2.0E-01	mg/kg/day	3.6E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	4.0E-06	mg/kg/day	2.0E-03	mg/kg/day	2.0E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-04	mg/kg/day	4.7E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	3.0E-03	mg/kg/day	1.8E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	3.0E-04	mg/kg/day	1.5E+00
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	8.8E-05	mg/kg/day	4.0E-02	mg/kg/day	2.2E-03
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	7.3E-01	mg/kg/day	7.0E-01	mg/kg/day	1.0E+00
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	5.3E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	2.4E-02	mg/kg/day	9.6E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	8.2E-07	mg/kg/day	3.0E-04	mg/kg/day	2.7E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	5.0E-03	mg/kg/day	2.9E-02
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	2.0E-02	mg/kg/day	2.4E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.3E-03
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	2.2E-01	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	5.0E-03	mg/kg/day	6.4E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	5.0E-03	mg/kg/day	2.4E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	9.0E-02	mg/kg/day	3.0E-01	mg/kg/day	3.0E-01
			Exp. Route Total								NA					6.2E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.0E+00	mg/kg/day	1.3E-04
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	6.0E-05	mg/kg/day	2.7E-03
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	9.5E-06	mg/kg/day	3.0E-04	mg/kg/day	3.2E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.4E-02	mg/kg/day	1.0E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	7.9E-08	mg/kg/day	1.4E-05	mg/kg/day	5.6E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	4.6E-06	mg/kg/day	2.5E-05	mg/kg/day	1.8E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	2.1E-06	mg/kg/day	7.5E-05	mg/kg/day	2.8E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	3.5E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	4.0E-02	mg/kg/day	4.3E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	7.0E-01	mg/kg/day	2.1E-02
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	9.6E-04	mg/kg/day	4.7E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.6E-08	mg/kg/day	2.1E-05	mg/kg/day	7.7E-04
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	5.0E-03	mg/kg/day	5.6E-04
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	8.0E-04	mg/kg/day	2.3E-02
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	2.3E-07	mg/kg/day	5.0E-03	mg/kg/day	4.5E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	3.8E-08	mg/kg/day	2.0E-04	mg/kg/day	1.9E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	6.4E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	1.3E-04	mg/kg/day	1.8E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	3.0E-01	mg/kg/day	3.5E-03
			Exp. Route Total								NA					8.0E-01
		Exposure Point Total									NA					7.0E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	7.8E-02	mg/m^3	NA	NA	NA	NA	NA	3.3E-03	mg/m^3	5.0E-03	mg/m3	6.5E-01
				Antimony	9.4E-05	mg/m^3	NA	NA	NA	NA	NA	3.9E-06	mg/m^3	NA	NA	NA
				Arsenic	5.6E-03	mg/m^3	NA	NA	NA	NA	NA	2.3E-04	mg/m^3	1.5E-05	mg/m3	1.6E+01
				Barium	8.3E-03	mg/m^3	NA	NA	NA	NA	NA	3.5E-04	mg/m^3	5.0E-04	mg/m3	6.9E-01
				Beryllium	4.6E-05	mg/m^3	NA	NA	NA	NA	NA	1.9E-06	mg/m^3	2.0E-05	mg/m3	9.7E-02
				Cadmium (water)	2.7E-03	mg/m^3	NA	NA	NA	NA	NA	1.1E-04	mg/m^3	1.0E-05	mg/m3	1.1E+01
				Chromium (hexavalent)	6.2E-04	mg/m^3	NA	NA	NA	NA	NA	2.6E-05	mg/m^3	8.0E-06	mg/m3	3.2E+00
				Cobalt	5.2E-03	mg/m^3	NA	NA	NA	NA	NA	2.2E-04	mg/m^3	6.0E-06	mg/m3	3.6E+01
				Copper	1.0E-03	mg/m^3	NA	NA	NA	NA	NA	4.2E-05	mg/m^3	NA	NA	NA
				Iron	8.5E+00	mg/m^3	NA	NA	NA	NA	NA	3.5E-01	mg/m^3	NA	NA	NA
				Lead	6.1E-03	mg/m^3	NA	NA	NA	NA	NA	2.5E-04	mg/m^3	NA	NA	NA
				Manganese (non-diet)	2.7E-01	mg/m^3	NA	NA	NA	NA	NA	1.1E-02	mg/m^3	5.0E-05	mg/m3	2.2E+02
				Mercury (HgCl)	9.6E-06	mg/m^3	NA	NA	NA	NA	NA	4.0E-07	mg/m^3	NA	NA	NA
				Molybdenum	1.7E-03	mg/m^3	NA	NA	NA	NA	NA	6.9E-05	mg/m^3	NA	NA	NA
				Nickel	5.5E-02	mg/m^3	NA	NA	NA	NA	NA	2.3E-03	mg/m^3	9.0E-05	mg/m3	2.6E+01
				Selenium	1.3E-04	mg/m^3	NA	NA	NA	NA	NA	5.6E-06	mg/m^3	2.0E-02	mg/m3	2.8E-04
				Silica (as SIO2)	2.6E+00	mg/m^3	NA	NA	NA	NA	NA	1.1E-01	mg/m^3	NA	NA	NA
				Silver	3.7E-05	mg/m^3	NA	NA	NA	NA	NA	1.5E-06	mg/m^3	NA	NA	NA
				Thallium	3.8E-05	mg/m^3	NA	NA	NA	NA	NA	1.6E-06	mg/m^3	NA	NA	NA
				Vanadium	1.4E-03	mg/m^3	NA	NA	NA	NA	NA	5.7E-05	mg/m^3	1.0E-04	mg/m3	5.7E-01
				Zinc	1.0E+00	mg/m^3	NA	NA	NA	NA	NA	4.4E-02	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					3.2E+02
		Exposure Point Total									NA					3.2E+02
	Exposure Medium Total										NA					3.5E+02
Medium Total											NA					3.5E+02

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	1.0E+00	mg/kg/day	6.6E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.8E-01
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.6E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-03	mg/kg/day	6.9E-03
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	1.0E-03	mg/kg/day	8.5E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	1.5E+00	mg/kg/day	3.9E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	7.0E-01	mg/kg/day	2.0E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.4E-01	mg/kg/day	7.6E-02
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	1.0E-04	mg/kg/day	5.3E-01
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	5.9E-03
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	5.0E-03	mg/kg/day	2.1E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	5.0E-03	mg/kg/day	6.7E-02
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-03	mg/kg/day	4.6E-02
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	3.0E-01	mg/kg/day	1.3E-01
			Exp. Route Total								NA					2.3E+00
		Exposure Point Total									NA					2.3E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	6.0E-02	mg/kg/day	1.0E+00	mg/kg/day	6.0E-02
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-04	mg/kg/day	8.3E-01
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-02	mg/kg/day	2.0E-01	mg/kg/day	2.2E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-03	mg/kg/day	8.1E-02
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	1.0E-03	mg/kg/day	2.7E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.7E-02
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	4.0E-02	mg/kg/day	3.3E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	7.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.0E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	5.2E-01	mg/kg/day	1.4E-01	mg/kg/day	3.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	1.0E-04	mg/kg/day	5.1E-02
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.3E-03
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	5.0E-03	mg/kg/day	7.5E-01
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	5.0E-03	mg/kg/day	6.2E-02
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	3.0E-01	mg/kg/day	6.6E-01
			Exp. Route Total								NA					6.9E+00
		Exposure Point Total									NA					6.9E+00

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	1.5E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.3E-02
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.7E-03
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.0E-03	mg/kg/day	3.4E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.0E-03	mg/kg/day	2.0E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.0E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	5.0E-03
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-03	mg/kg/day	7.0E-01	mg/kg/day	4.0E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.4E-01	mg/kg/day	9.9E-03
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-06	mg/kg/day	1.0E-04	mg/kg/day	5.9E-02
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	2.0E-02	mg/kg/day	2.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	5.0E-03	mg/kg/day	5.7E-02
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	6.9E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-03	mg/kg/day	3.0E-01	mg/kg/day	3.1E-02
			Exp. Route Total								NA					2.8E-01
		Exposure Point Total									NA					2.8E-01

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	1.0E+00	mg/kg/day	4.8E-03
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.6E-01
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	2.0E-01	mg/kg/day	5.3E-04
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	2.0E-03	mg/kg/day	2.0E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E-03	mg/kg/day	4.6E-02
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	1.5E+00	mg/kg/day	2.1E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	4.0E-02	mg/kg/day	3.6E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	7.0E-01	mg/kg/day	5.4E-02
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	1.4E-01	mg/kg/day	2.4E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	1.0E-04	mg/kg/day	5.7E-01
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	2.0E-02	mg/kg/day	1.8E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					2.0E+00
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total										NA					1.1E+01

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	7.4E-01	mg/kg/day	1.0E+00	mg/kg/day	7.4E-01
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	3.0E-04	mg/kg/day	9.7E-01
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	2.0E-01	mg/kg/day	2.0E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	2.0E-03	mg/kg/day	3.9E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	1.0E-03	mg/kg/day	2.8E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	1.5E+00	mg/kg/day	3.4E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	7.1E-03	mg/kg/day	3.0E-04	mg/kg/day	2.4E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-02	mg/kg/day	4.0E-02	mg/kg/day	9.1E-01
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+01	mg/kg/day	7.0E-01	mg/kg/day	1.7E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	5.7E-01	mg/kg/day	1.4E-01	mg/kg/day	4.1E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	8.6E-05	mg/kg/day	1.0E-04	mg/kg/day	8.6E-01
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-02	mg/kg/day	1.6E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.5E-02
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	5.0E-03	mg/kg/day	9.5E-01
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+00	mg/kg/day	3.0E-01	mg/kg/day	9.1E+00
			Exp. Route Total								NA					8.8E+01
		Exposure Point Total									NA					8.8E+01

TABLE 7.8.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	3.0E-04	mg/kg/day	7.2E-04
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	2.5E-05	mg/kg/day	6.7E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.4E-03
		Exposure Point Total									NA					7.4E-03
	Exposure Medium Total										NA					8.8E+01
Medium Total											NA					1.0E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					5E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.8.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	312	234
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	4.7E-01	1.0E-03	6.0	2.8E-06	6.0	2.8E-06	1.8E+01
Antimony	5.7E-04	1.0E-03	6.0	3.4E-09	6.0	3.4E-09	2.1E-02
Arsenic	3.4E-02	1.0E-03	6.0	2.0E-07	6.0	2.0E-07	1.3E+00
Barium	5.0E-02	1.0E-03	6.0	3.0E-07	6.0	3.0E-07	1.9E+00
Beryllium	2.8E-04	1.0E-03	6.0	1.7E-09	6.0	1.7E-09	1.0E-02
Cadmium (water)	1.6E-02	1.0E-03	6.0	9.8E-08	6.0	9.8E-08	6.1E-01
Chromium (hexavalent)	3.7E-03	2.0E-03	6.0	4.5E-08	6.0	4.5E-08	2.8E-01
Cobalt	3.2E-02	4.0E-04	6.0	7.6E-08	6.0	7.6E-08	4.7E-01
Copper	6.1E-03	1.0E-03	6.0	3.7E-08	6.0	3.7E-08	2.3E-01
Iron	5.1E+01	1.0E-03	6.0	3.1E-04	6.0	3.1E-04	1.9E+03
Lead	3.7E-02	1.0E-04	6.0	2.2E-08	6.0	2.2E-08	1.4E-01
Manganese (non-diet)	1.6E+00	1.0E-03	6.0	9.7E-06	6.0	9.7E-06	6.0E+01
Mercury (HgCl)	5.8E-05	1.0E-03	6.0	3.5E-10	6.0	3.5E-10	2.1E-03
Molybdenum	1.0E-02	1.0E-03	6.0	6.0E-08	6.0	6.0E-08	3.7E-01
Nickel	3.3E-01	2.0E-04	6.0	4.0E-07	6.0	4.0E-07	2.5E+00
Selenium	8.1E-04	1.0E-03	6.0	4.9E-09	6.0	4.9E-09	3.0E-02
Silica (as SIO2)	1.6E+01	1.0E-03	6.0	9.3E-05	6.0	9.3E-05	5.8E+02
Silver	2.2E-04	6.0E-04	6.0	8.1E-10	6.0	8.1E-10	5.0E-03
Thallium	2.3E-04	1.0E-03	6.0	1.4E-09	6.0	1.4E-09	8.5E-03
Vanadium	8.2E-03	1.0E-03	6.0	4.9E-08	6.0	4.9E-08	3.1E-01
Zinc	6.3E+00	6.0E-04	6.0	2.3E-05	6.0	2.3E-05	1.4E+02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.8.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	4.7E-01	1.0E-03	0.71	3.3E-07	0.54	2.5E-07	2.4E+00
Antimony	5.7E-04	1.0E-03	0.71	4.0E-10	0.54	3.1E-10	2.9E-03
Arsenic	3.4E-02	1.0E-03	0.71	2.4E-08	0.54	1.8E-08	1.7E-01
Barium	5.0E-02	1.0E-03	0.71	3.6E-08	0.54	2.7E-08	2.6E-01
Beryllium	2.8E-04	1.0E-03	0.71	2.0E-10	0.54	1.5E-10	1.4E-03
Cadmium (water)	1.6E-02	1.0E-03	0.71	1.2E-08	0.54	8.8E-09	8.4E-02
Chromium (hexavalent)	3.7E-03	2.0E-03	0.71	5.3E-09	0.54	4.0E-09	3.9E-02
Cobalt	3.2E-02	4.0E-04	0.71	9.0E-09	0.54	6.8E-09	6.5E-02
Copper	6.1E-03	1.0E-03	0.71	4.4E-09	0.54	3.3E-09	3.2E-02
Iron	5.1E+01	1.0E-03	0.71	3.6E-05	0.54	2.8E-05	2.6E+02
Lead	3.7E-02	1.0E-04	0.71	2.6E-09	0.54	2.0E-09	1.9E-02
Manganese (non-diet)	1.6E+00	1.0E-03	0.71	1.1E-06	0.54	8.7E-07	8.3E+00
Mercury (HgCl)	5.8E-05	1.0E-03	0.71	4.1E-11	0.54	3.1E-11	3.0E-04
Molybdenum	1.0E-02	1.0E-03	0.71	7.1E-09	0.54	5.4E-09	5.2E-02
Nickel	3.3E-01	2.0E-04	0.71	4.7E-08	0.54	3.6E-08	3.4E-01
Selenium	8.1E-04	1.0E-03	0.71	5.7E-10	0.54	4.4E-10	4.2E-03
Silica (as SIO2)	1.6E+01	1.0E-03	0.71	1.1E-05	0.54	8.4E-06	8.0E+01
Silver	2.2E-04	6.0E-04	0.71	9.5E-11	0.54	7.3E-11	6.9E-04
Thallium	2.3E-04	1.0E-03	0.71	1.6E-10	0.54	1.2E-10	1.2E-03
Vanadium	8.2E-03	1.0E-03	0.71	5.9E-09	0.54	4.4E-09	4.3E-02
Zinc	6.3E+00	6.0E-04	0.71	2.7E-06	0.54	2.0E-06	1.9E+01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.8.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Sweat Lodge

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	4
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	4.7E-01	1.0E-03	1.0	4.7E-07	1.0	4.7E-07	3.4E+00
Antimony	5.7E-04	1.0E-03	1.0	5.7E-10	1.0	5.7E-10	4.1E-03
Arsenic	3.4E-02	1.0E-03	1.0	3.4E-08	1.0	3.4E-08	2.4E-01
Barium	5.0E-02	1.0E-03	1.0	5.0E-08	1.0	5.0E-08	3.6E-01
Beryllium	2.8E-04	1.0E-03	1.0	2.8E-10	1.0	2.8E-10	2.0E-03
Cadmium (water)	1.6E-02	1.0E-03	1.0	1.6E-08	1.0	1.6E-08	1.2E-01
Chromium (hexavalent)	3.7E-03	2.0E-03	1.0	7.5E-09	1.0	7.5E-09	5.4E-02
Cobalt	3.2E-02	4.0E-04	1.0	1.3E-08	1.0	1.3E-08	9.1E-02
Copper	6.1E-03	1.0E-03	1.0	6.1E-09	1.0	6.1E-09	4.4E-02
Iron	5.1E+01	1.0E-03	1.0	5.1E-05	1.0	5.1E-05	3.7E+02
Lead	3.7E-02	1.0E-04	1.0	3.7E-09	1.0	3.7E-09	2.6E-02
Manganese (non-diet)	1.6E+00	1.0E-03	1.0	1.6E-06	1.0	1.6E-06	1.2E+01
Mercury (HgCl)	5.8E-05	1.0E-03	1.0	5.8E-11	1.0	5.8E-11	4.1E-04
Molybdenum	1.0E-02	1.0E-03	1.0	1.0E-08	1.0	1.0E-08	7.2E-02
Nickel	3.3E-01	2.0E-04	1.0	6.7E-08	1.0	6.7E-08	4.8E-01
Selenium	8.1E-04	1.0E-03	1.0	8.1E-10	1.0	8.1E-10	5.8E-03
Silica (as SIO2)	1.6E+01	1.0E-03	1.0	1.6E-05	1.0	1.6E-05	1.1E+02
Silver	2.2E-04	6.0E-04	1.0	1.3E-10	1.0	1.3E-10	9.6E-04
Thallium	2.3E-04	1.0E-03	1.0	2.3E-10	1.0	2.3E-10	1.6E-03
Vanadium	8.2E-03	1.0E-03	1.0	8.2E-09	1.0	8.2E-09	5.9E-02
Zinc	6.3E+00	6.0E-04	1.0	3.8E-06	1.0	3.8E-06	2.7E+01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	1.0E+00	mg/kg/day	3.1E-01
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-04	mg/kg/day	4.2E+00
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	6.2E-04	mg/kg/day	3.0E-04	mg/kg/day	2.1E+00
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	3.8E-03	mg/kg/day	2.0E-01	mg/kg/day	1.9E-02
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	2.0E-03	mg/kg/day	1.4E-02
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	8.1E-03	mg/kg/day	1.0E-03	mg/kg/day	8.1E+00
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	7.6E-04	mg/kg/day	1.5E+00	mg/kg/day	5.1E-04
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.6E-04	mg/kg/day	3.0E-04	mg/kg/day	2.9E+00
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	4.0E-02	mg/kg/day	4.9E-02
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	2.1E+00	mg/kg/day	7.0E-01	mg/kg/day	3.0E+00
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-04	mg/kg/day	2.0E-03	mg/kg/day	4.6E-01
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	2.1E-02	mg/kg/day	2.4E-02	mg/kg/day	8.6E-01
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-06	mg/kg/day	3.0E-04	mg/kg/day	1.8E-02
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	5.0E-03	mg/kg/day	4.6E-01
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	2.0E-02	mg/kg/day	5.4E-02
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	5.0E-03	mg/kg/day	2.4E-02
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	5.0E-03	mg/kg/day	4.2E-03
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	6.0E-01	mg/kg/day	3.4E-03
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-05	mg/kg/day	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	5.0E-03	mg/kg/day	2.8E-01
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	4.9E-01	mg/kg/day	3.0E-01	mg/kg/day	1.6E+00
			Exp. Route Total								NA					2.4E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	5.0E-05	mg/kg/day	3.0E-04	mg/kg/day	1.7E-01
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	2.5E-05	mg/kg/day	5.2E-01
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					6.8E-01
		Exposure Point Total									NA					2.5E+01
	Exposure Medium Total										NA					2.5E+01
Medium Total											NA					2.5E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	1.0E+00	mg/kg/day	1.4E-02
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	4.0E-04	mg/kg/day	4.4E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	3.0E-04	mg/kg/day	3.5E+00
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.7E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	8.6E-06	mg/kg/day	2.0E-03	mg/kg/day	4.3E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	5.0E-04	mg/kg/day	1.0E+00
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	3.0E-03	mg/kg/day	3.8E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	9.7E-04	mg/kg/day	3.0E-04	mg/kg/day	3.2E+00
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	4.0E-02	mg/kg/day	4.7E-03
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.6E+00	mg/kg/day	7.0E-01	mg/kg/day	2.3E+00
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	5.0E-02	mg/kg/day	2.4E-02	mg/kg/day	2.1E+00
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	3.0E-04	mg/kg/day	5.9E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	5.0E-03	mg/kg/day	6.2E-02
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.0E-02	mg/kg/day	2.0E-02	mg/kg/day	5.1E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	5.0E-03	mg/kg/day	5.0E-03
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	4.8E-01	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	5.0E-03	mg/kg/day	1.4E-03
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	7.0E-06	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	5.0E-03	mg/kg/day	5.1E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	1.9E-01	mg/kg/day	3.0E-01	mg/kg/day	6.5E-01
			Exp. Route Total								NA					1.3E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	4.71E-01	mg/L	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	1.0E+00	mg/kg/day	7.7E-04
				Antimony	5.68E-04	mg/L	NA	NA	NA	NA	NA	9.3E-07	mg/kg/day	6.0E-05	mg/kg/day	1.5E-02
				Arsenic	3.39E-02	mg/L	NA	NA	NA	NA	NA	5.5E-05	mg/kg/day	3.0E-04	mg/kg/day	1.8E-01
				Barium	5.00E-02	mg/L	NA	NA	NA	NA	NA	8.2E-05	mg/kg/day	1.4E-02	mg/kg/day	5.8E-03
				Beryllium	2.80E-04	mg/L	NA	NA	NA	NA	NA	4.6E-07	mg/kg/day	1.4E-05	mg/kg/day	3.3E-02
				Cadmium (water)	1.63E-02	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	2.5E-05	mg/kg/day	1.1E+00
				Chromium (hexavalent)	3.74E-03	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	7.5E-05	mg/kg/day	1.6E-01
				Cobalt	3.16E-02	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	3.0E-04	mg/kg/day	6.9E-02
				Copper	6.13E-03	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	4.0E-02	mg/kg/day	2.5E-04
				Iron	5.13E+01	mg/L	NA	NA	NA	NA	NA	8.4E-02	mg/kg/day	7.0E-01	mg/kg/day	1.2E-01
				Lead	3.68E-02	mg/L	NA	NA	NA	NA	NA	6.0E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.62E+00	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	9.6E-04	mg/kg/day	2.8E+00
				Mercury (HgCl)	5.77E-05	mg/L	NA	NA	NA	NA	NA	9.4E-08	mg/kg/day	2.1E-05	mg/kg/day	4.5E-03
				Molybdenum	1.00E-02	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	5.0E-03	mg/kg/day	3.3E-03
				Nickel	3.34E-01	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	8.0E-04	mg/kg/day	1.4E-01
				Selenium	8.10E-04	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	5.0E-03	mg/kg/day	2.6E-04
				Silica (as SIO2)	1.56E+01	mg/L	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	NA	NA	NA
				Silver	2.24E-04	mg/L	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	2.0E-04	mg/kg/day	1.1E-03
				Thallium	2.27E-04	mg/L	NA	NA	NA	NA	NA	3.7E-07	mg/kg/day	NA	NA	NA
				Vanadium	8.24E-03	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	1.3E-04	mg/kg/day	1.0E-01
				Zinc	6.29E+00	mg/L	NA	NA	NA	NA	NA	6.2E-03	mg/kg/day	3.0E-01	mg/kg/day	2.1E-02
			Exp. Route Total								NA					4.7E+00
		Exposure Point Total									NA					1.8E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	2.4E-02	mg/kg/day	1.0E+00	mg/kg/day	2.4E-02
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	4.0E-04	mg/kg/day	7.4E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	3.0E-04	mg/kg/day	5.9E+00
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.3E-02
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	2.0E-03	mg/kg/day	7.3E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	8.5E-04	mg/kg/day	5.0E-04	mg/kg/day	1.7E+00
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	3.0E-03	mg/kg/day	6.5E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	3.0E-04	mg/kg/day	5.5E+00
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	4.0E-02	mg/kg/day	8.0E-03
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	2.7E+00	mg/kg/day	7.0E-01	mg/kg/day	3.8E+00
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	8.4E-02	mg/kg/day	2.4E-02	mg/kg/day	3.5E+00
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	3.0E-06	mg/kg/day	3.0E-04	mg/kg/day	1.0E-02
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	5.2E-04	mg/kg/day	5.0E-03	mg/kg/day	1.0E-01
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.7E-02	mg/kg/day	2.0E-02	mg/kg/day	8.7E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	5.0E-03	mg/kg/day	8.4E-03
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	8.1E-01	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.3E-03
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	4.3E-04	mg/kg/day	5.0E-03	mg/kg/day	8.6E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	3.3E-01	mg/kg/day	3.0E-01	mg/kg/day	1.1E+00
			Exp. Route Total								NA					2.3E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E+00	mg/kg/day	1.1E-04
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	6.0E-05	mg/kg/day	2.2E-03
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	7.8E-06	mg/kg/day	3.0E-04	mg/kg/day	2.6E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	1.4E-02	mg/kg/day	8.2E-04
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	6.4E-08	mg/kg/day	1.4E-05	mg/kg/day	4.6E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	3.7E-06	mg/kg/day	2.5E-05	mg/kg/day	1.5E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	7.5E-05	mg/kg/day	2.3E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	3.0E-04	mg/kg/day	9.7E-03
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	4.0E-02	mg/kg/day	3.5E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.7E-02
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	8.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	3.7E-04	mg/kg/day	9.6E-04	mg/kg/day	3.9E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.3E-08	mg/kg/day	2.1E-05	mg/kg/day	6.3E-04
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	5.0E-03	mg/kg/day	4.6E-04
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	8.0E-04	mg/kg/day	1.9E-02
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	5.0E-03	mg/kg/day	3.7E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	3.1E-08	mg/kg/day	2.0E-04	mg/kg/day	1.5E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	5.2E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	1.9E-06	mg/kg/day	1.3E-04	mg/kg/day	1.5E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	8.7E-04	mg/kg/day	3.0E-01	mg/kg/day	2.9E-03
			Exp. Route Total								NA					6.6E-01
		Exposure Point Total									NA					2.3E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	3.1E-02	mg/kg/day	1.0E+00	mg/kg/day	3.1E-02
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	4.0E-04	mg/kg/day	9.5E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	3.0E-04	mg/kg/day	7.5E+00
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	2.0E-01	mg/kg/day	1.7E-02
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	2.0E-03	mg/kg/day	9.3E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	5.0E-04	mg/kg/day	2.2E+00
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-03	mg/kg/day	8.3E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.1E-03	mg/kg/day	3.0E-04	mg/kg/day	7.0E+00
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.0E-02
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	3.4E+00	mg/kg/day	7.0E-01	mg/kg/day	4.9E+00
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	2.4E-02	mg/kg/day	4.5E+00
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	3.8E-06	mg/kg/day	3.0E-04	mg/kg/day	1.3E-02
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	2.0E-02	mg/kg/day	1.1E+00
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	5.4E-05	mg/kg/day	5.0E-03	mg/kg/day	1.1E-02
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	3.0E-03
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	5.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.1E-01
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	4.2E-01	mg/kg/day	3.0E-01	mg/kg/day	1.4E+00
			Exp. Route Total								NA					2.9E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E+00	mg/kg/day	2.0E-04
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	6.0E-05	mg/kg/day	4.0E-03
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	3.0E-04	mg/kg/day	4.8E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	1.4E-02	mg/kg/day	1.5E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	1.4E-05	mg/kg/day	8.5E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.5E-05	mg/kg/day	2.8E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	7.5E-05	mg/kg/day	4.2E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	5.4E-06	mg/kg/day	3.0E-04	mg/kg/day	1.8E-02
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	4.0E-02	mg/kg/day	6.5E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	7.0E-01	mg/kg/day	3.1E-02
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	6.9E-04	mg/kg/day	9.6E-04	mg/kg/day	7.2E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	2.4E-08	mg/kg/day	2.1E-05	mg/kg/day	1.2E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	4.2E-06	mg/kg/day	5.0E-03	mg/kg/day	8.5E-04
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	8.0E-04	mg/kg/day	3.5E-02
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	5.0E-03	mg/kg/day	6.9E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	5.7E-08	mg/kg/day	2.0E-04	mg/kg/day	2.8E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	9.6E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	3.5E-06	mg/kg/day	1.3E-04	mg/kg/day	2.7E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	3.0E-01	mg/kg/day	5.3E-03
			Exp. Route Total								NA					1.2E+00
		Exposure Point Total									NA					3.0E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	7.8E-02	mg/m^3	NA	NA	NA	NA	NA	3.3E-03	mg/m^3	5.0E-03	mg/m3	6.5E-01
				Antimony	9.4E-05	mg/m^3	NA	NA	NA	NA	NA	3.9E-06	mg/m^3	NA	NA	NA
				Arsenic	5.6E-03	mg/m^3	NA	NA	NA	NA	NA	2.3E-04	mg/m^3	1.5E-05	mg/m3	1.6E+01
				Barium	8.3E-03	mg/m^3	NA	NA	NA	NA	NA	3.5E-04	mg/m^3	5.0E-04	mg/m3	6.9E-01
				Beryllium	4.6E-05	mg/m^3	NA	NA	NA	NA	NA	1.9E-06	mg/m^3	2.0E-05	mg/m3	9.7E-02
				Cadmium (water)	2.7E-03	mg/m^3	NA	NA	NA	NA	NA	1.1E-04	mg/m^3	1.0E-05	mg/m3	1.1E+01
				Chromium (hexavalent)	6.2E-04	mg/m^3	NA	NA	NA	NA	NA	2.6E-05	mg/m^3	8.0E-06	mg/m3	3.2E+00
				Cobalt	5.2E-03	mg/m^3	NA	NA	NA	NA	NA	2.2E-04	mg/m^3	6.0E-06	mg/m3	3.6E+01
				Copper	1.0E-03	mg/m^3	NA	NA	NA	NA	NA	4.2E-05	mg/m^3	NA	NA	NA
				Iron	8.5E+00	mg/m^3	NA	NA	NA	NA	NA	3.5E-01	mg/m^3	NA	NA	NA
				Lead	6.1E-03	mg/m^3	NA	NA	NA	NA	NA	2.5E-04	mg/m^3	NA	NA	NA
				Manganese (non-diet)	2.7E-01	mg/m^3	NA	NA	NA	NA	NA	1.1E-02	mg/m^3	5.0E-05	mg/m3	2.2E+02
				Mercury (HgCl)	9.6E-06	mg/m^3	NA	NA	NA	NA	NA	4.0E-07	mg/m^3	NA	NA	NA
				Molybdenum	1.7E-03	mg/m^3	NA	NA	NA	NA	NA	6.9E-05	mg/m^3	NA	NA	NA
				Nickel	5.5E-02	mg/m^3	NA	NA	NA	NA	NA	2.3E-03	mg/m^3	9.0E-05	mg/m3	2.6E+01
				Selenium	1.3E-04	mg/m^3	NA	NA	NA	NA	NA	5.6E-06	mg/m^3	2.0E-02	mg/m3	2.8E-04
				Silica (as SIO2)	2.6E+00	mg/m^3	NA	NA	NA	NA	NA	1.1E-01	mg/m^3	NA	NA	NA
				Silver	3.7E-05	mg/m^3	NA	NA	NA	NA	NA	1.5E-06	mg/m^3	NA	NA	NA
				Thallium	3.8E-05	mg/m^3	NA	NA	NA	NA	NA	1.6E-06	mg/m^3	NA	NA	NA
				Vanadium	1.4E-03	mg/m^3	NA	NA	NA	NA	NA	5.7E-05	mg/m^3	1.0E-04	mg/m3	5.7E-01
				Zinc	1.0E+00	mg/m^3	NA	NA	NA	NA	NA	4.4E-02	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					3.2E+02
		Exposure Point Total									NA					3.2E+02
	Exposure Medium Total										NA					3.9E+02
Medium Total											NA					3.9E+02

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	1.0E+00	mg/kg/day	1.5E-02
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	9.5E-05	mg/kg/day	3.0E-04	mg/kg/day	3.2E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-01	mg/kg/day	3.7E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	2.0E-03	mg/kg/day	1.6E-02
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-03	mg/kg/day	2.0E-01
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.5E+00	mg/kg/day	9.1E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.7E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-02	mg/kg/day	4.2E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-02	mg/kg/day	7.0E-01	mg/kg/day	4.6E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	1.4E-01	mg/kg/day	1.8E-01
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E-04	mg/kg/day	1.2E+00
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	5.0E-03	mg/kg/day	4.9E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	7.9E-04	mg/kg/day	5.0E-03	mg/kg/day	1.6E-01
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	5.0E-03	mg/kg/day	1.1E-01
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	8.9E-02	mg/kg/day	3.0E-01	mg/kg/day	3.0E-01
			Exp. Route Total								NA					5.4E+00
		Exposure Point Total									NA					5.4E+00

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-01	mg/kg/day	1.0E+00	mg/kg/day	1.4E-01
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	3.0E-04	mg/kg/day	1.9E+00
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	2.0E-01	mg/kg/day	5.1E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	2.0E-03	mg/kg/day	1.9E-01
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	6.4E-04	mg/kg/day	1.0E-03	mg/kg/day	6.4E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	1.5E+00	mg/kg/day	3.6E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	3.0E-04	mg/kg/day	2.3E-01
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	4.0E-02	mg/kg/day	7.8E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-01	mg/kg/day	7.0E-01	mg/kg/day	2.4E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+00	mg/kg/day	1.4E-01	mg/kg/day	8.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.0E-04	mg/kg/day	1.2E-01
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.9E-02
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	5.0E-03	mg/kg/day	1.7E+00
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	5.0E-03	mg/kg/day	1.4E-01
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	3.0E-01	mg/kg/day	1.5E+00
			Exp. Route Total								NA					1.6E+01
		Exposure Point Total									NA					1.6E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	1.0E+00	mg/kg/day	3.4E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.0E-03	mg/kg/day	8.0E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	1.0E-03	mg/kg/day	4.8E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	1.5E+00	mg/kg/day	2.4E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.2E-02
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	7.0E-01	mg/kg/day	9.4E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	1.4E-01	mg/kg/day	2.3E-02
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E-04	mg/kg/day	1.4E-01
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	2.0E-02	mg/kg/day	5.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	6.6E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	3.0E-01	mg/kg/day	7.2E-02
			Exp. Route Total								NA					6.5E-01
		Exposure Point Total									NA					6.5E-01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	3.0E-04	mg/kg/day	3.0E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	2.0E-01	mg/kg/day	1.2E-03
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	9.2E-05	mg/kg/day	2.0E-03	mg/kg/day	4.6E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-03	mg/kg/day	1.1E-01
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	1.5E+00	mg/kg/day	4.9E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	4.0E-02	mg/kg/day	8.4E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.8E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.8E-04	mg/kg/day	1.4E-01	mg/kg/day	5.6E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.0E-04	mg/kg/day	1.3E+00
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	8.5E-04	mg/kg/day	2.0E-02	mg/kg/day	4.3E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	3.0E-01	mg/kg/day	3.5E-01
			Exp. Route Total								NA					4.6E+00
		Exposure Point Total									NA					4.6E+00
	Exposure Medium Total										NA					2.7E+01

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	1.7E+00	mg/kg/day	1.0E+00	mg/kg/day	1.7E+00
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-04	mg/kg/day	4.2E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	6.8E-04	mg/kg/day	3.0E-04	mg/kg/day	2.3E+00
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	9.2E-02	mg/kg/day	2.0E-01	mg/kg/day	4.6E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	2.0E-03	mg/kg/day	9.2E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	6.6E-02	mg/kg/day	1.0E-03	mg/kg/day	6.6E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	1.5E+00	mg/kg/day	7.8E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-02	mg/kg/day	3.0E-04	mg/kg/day	5.5E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-02	mg/kg/day	4.0E-02	mg/kg/day	2.1E+00
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+01	mg/kg/day	7.0E-01	mg/kg/day	3.9E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	1.3E+00	mg/kg/day	1.4E-01	mg/kg/day	9.5E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-04	mg/kg/day	2.0E+00
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-02	mg/kg/day	3.8E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	5.0E-03	mg/kg/day	2.2E+00
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	6.4E+00	mg/kg/day	3.0E-01	mg/kg/day	2.1E+01
			Exp. Route Total								NA					2.1E+02
		Exposure Point Total									NA					2.1E+02

TABLE 7.9.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	2.5E-05	mg/kg/day	9.5E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.1E-02
		Exposure Point Total									NA					1.1E-02
	Exposure Medium Total										NA					2.1E+02
Medium Total											NA					2.3E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					6E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	8.9E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	7.3E+01	mg/kg	4.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+01	mg/kg	1.8E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.6E-04	NA	NA	NA	NA	NA
				Barium	1.7E+02	mg/kg	1.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E+00	mg/kg	7.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.6E+02	mg/kg	2.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	2.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.8E+01	mg/kg	2.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	8.6E+01	mg/kg	5.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.3E+04	mg/kg	6.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+03	mg/kg	7.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	9.0E+02	mg/kg	5.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	2.4E-01	mg/kg	1.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	6.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	4.8E+01	mg/kg	3.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	1.1E+03	mg/kg	7.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	4.7E+03	mg/kg	3.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	5.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	8.9E+01	mg/kg	5.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	9.8E-01	mg/kg	6.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	4.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.1E+04	mg/kg	1.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.6E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+01	mg/kg	3.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.1E-05	NA	NA	NA	NA	NA
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.6E+02	mg/kg	8.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								5.1E-05					NA
		Exposure Point Total									3.2E-04					NA
	Exposure Medium Total										3.2E-04					NA
Medium Total											3.2E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	4.7E-01	mg/L	4.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	5.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	3.0E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.5E-04	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	4.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	2.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	3.3E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	3.4E-05	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	2.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	5.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	4.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	1.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	5.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	8.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	2.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	7.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	1.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	2.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	2.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	7.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	5.5E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	4.7E-01	mg/L	6.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	8.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	4.9E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	7.4E-05	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	7.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	4.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	2.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	1.1E-05	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.3E-04	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	1.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	8.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	7.5E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	5.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	2.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	8.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	9.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	2.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	2.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	3.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	5.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.1E-04					NA
		Exposure Point Total									7.9E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	4.7E-01	mg/L	1.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	2.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	1.3E-03	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.9E-03	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	1.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	6.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	1.4E-04	mg/kg/day	5.0E-01	1/(mg/kg/day)	8.3E-05	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	2.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	1.9E+00	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	1.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	6.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	2.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	3.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	5.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	8.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	8.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	3.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	2.3E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.0E-03					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	6.8E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.0E-05	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	5.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	3.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	1.5E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	3.3E-05	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	7.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	3.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	1.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	2.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	2.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	4.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	7.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.3E-05					NA
		Exposure Point Total									2.0E-03					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	4.7E-01	mg/L	7.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	9.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	5.7E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	8.6E-04	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	8.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	4.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	2.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	6.3E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	3.7E-05	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	5.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	8.7E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	6.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	2.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	9.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	1.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	2.6E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	3.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	3.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	1.1E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								8.9E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	9.5E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.4E-05	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	1.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	7.9E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	4.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	2.1E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	3.5E-05	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	3.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	1.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	1.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	4.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	1.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	2.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	2.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	4.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	3.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	6.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	2.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	1.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.9E-05					NA
		Exposure Point Total									9.4E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	7.8E-02	mg/m^3	3.2E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.4E-05	mg/m^3	3.8E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.6E-03	mg/m^3	2.3E-04	mg/m^3	4.3E-03	1/(µg/m3)	9.8E-04	NA	NA	NA	NA	NA
				Barium	8.3E-03	mg/m^3	3.4E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.6E-05	mg/m^3	1.9E-06	mg/m^3	2.4E-03	1/(µg/m3)	4.5E-06	NA	NA	NA	NA	NA
				Cadmium (water)	2.7E-03	mg/m^3	1.1E-04	mg/m^3	1.8E-03	1/(µg/m3)	2.0E-04	NA	NA	NA	NA	NA
				Chromium (hexavalent)	6.2E-04	mg/m^3	2.5E-05	mg/m^3	8.4E-02	1/(µg/m3)	1.6E-03	NA	NA	NA	NA	NA
				Cobalt	5.2E-03	mg/m^3	2.1E-04	mg/m^3	9.0E-03	1/(µg/m3)	1.9E-03	NA	NA	NA	NA	NA
				Copper	1.0E-03	mg/m^3	4.1E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	8.5E+00	mg/m^3	3.4E-01	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.1E-03	mg/m^3	2.5E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.7E-01	mg/m^3	1.1E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	9.6E-06	mg/m^3	3.9E-07	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.7E-03	mg/m^3	6.7E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	5.5E-02	mg/m^3	2.2E-03	mg/m^3	2.6E-04	1/(µg/m3)	5.8E-04	NA	NA	NA	NA	NA
				Selenium	1.3E-04	mg/m^3	5.4E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	2.6E+00	mg/m^3	1.0E-01	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.7E-05	mg/m^3	1.5E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.8E-05	mg/m^3	1.5E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.4E-03	mg/m^3	5.5E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.0E+00	mg/m^3	4.2E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								5.3E-03					NA
		Exposure Point Total									5.3E-03					NA
	Exposure Medium Total										9.0E-03					NA
Medium Total											9.0E-03					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	7.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.2E-02	mg/kg	4.5E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-05	NA	NA	NA	NA	NA
				Barium	2.5E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E-02	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.6E-02	mg/kg	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	6.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	4.7E-02	mg/kg	6.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.6E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.1E+01	mg/kg	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.6E-01	mg/kg	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.1E-02	mg/kg	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.2E-02	mg/kg	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-01	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.6E-01	mg/kg	3.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.9E-01	mg/kg	5.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.0E+01	mg/kg	4.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.8E-05					NA
		Exposure Point Total									6.8E-05					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	6.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.8E-01	mg/kg	2.8E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.1E-04	NA	NA	NA	NA	NA
				Barium	1.0E+02	mg/kg	4.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.4E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.4E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.8E-02	mg/kg	3.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	3.1E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+02	mg/kg	8.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.9E+00	mg/kg	9.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	5.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.2E-02	mg/kg	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.9E-01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.7E+00	mg/kg	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.3E+02	mg/kg	3.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	7.2E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+02	mg/kg	2.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.1E-04					NA
		Exposure Point Total									4.1E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.5E-02	mg/kg	2.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.2E-05	NA	NA	NA	NA	NA
				Barium	4.5E+00	mg/kg	1.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E-02	mg/kg	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	5.9E-02	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.8E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	8.2E+00	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.7E-02	mg/kg	6.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.3E-01	mg/kg	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.3E-01	mg/kg	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.0E-01	mg/kg	7.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	5.7E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.7E+01	mg/kg	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.2E-05					NA
		Exposure Point Total									3.2E-05					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	5.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.1E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.9E-02	mg/kg	4.3E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.4E-05	NA	NA	NA	NA	NA
				Barium	1.1E-01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.0E-02	mg/kg	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	4.7E-02	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.2E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+01	mg/kg	4.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	5.1E-01	mg/kg	5.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	3.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.8E-02	mg/kg	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.7E-01	mg/kg	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	7.8E-01	mg/kg	8.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.6E-01	mg/kg	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+01	mg/kg	5.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-05					NA
		Exposure Point Total									6.4E-05					NA
	Exposure Medium Total										5.8E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	8.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.5E-01	mg/kg	3.2E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-04	NA	NA	NA	NA	NA
				Barium	2.1E+01	mg/kg	4.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.1E-02	mg/kg	8.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+01	mg/kg	3.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.7E+00	mg/kg	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.7E+00	mg/kg	7.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.9E+01	mg/kg	4.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.1E+03	mg/kg	1.3E+01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	7.1E+01	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	6.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.5E-02	mg/kg	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.7E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.7E-01	mg/kg	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	5.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.4E+03	mg/kg	3.1E+00	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-04					NA
		Exposure Point Total									4.8E-04					NA

TABLE 7.10.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.1E-01	mg/kg	2.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.3E-07	NA	NA	NA	NA	NA
				Barium	2.0E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	2.1E+01	mg/kg	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.7E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.2E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.3E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.6E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.8E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.3E-07					NA
		Exposure Point Total									3.3E-07					NA
	Exposure Medium Total										4.9E-04					NA
Medium Total											1.1E-03					NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											1E-02					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.10.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
							Value					Value					
					Value	Units	0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs	Units	0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)	Units	Cancer Risk (3)
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	3.7E-03	mg/L	3.3E-06	6.6E-06	3.6E-06	3.6E-06	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	3.4E-05
			Dermal	Chromium (hexavalent)	3.7E-03	mg/L	3.5E-07	7.0E-07	1.5E-06	1.5E-06	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.3E-04
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	3.7E-03	mg/L	5.6E-06	1.1E-05	1.9E-05	1.9E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	8.3E-05
			Dermal	Chromium (hexavalent)	3.7E-03	mg/L	4.9E-08	9.8E-08	2.1E-07	2.1E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	3.3E-05
		Surface Water (Sweat Lodge)	Ingestion	Chromium (hexavalent)	3.7E-03	mg/L	n/a	1.4E-05	7.6E-06	7.6E-06	mg/kg-day	n/a	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	3.7E-05
			Dermal	Chromium (hexavalent)	3.7E-03	mg/L	n/a	1.8E-07	3.0E-07	3.0E-07	mg/kg-day	n/a	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	3.5E-05
		Water Vapor (Sweat Lodge)	Inhalation	Chromium (hexavalent)	6.2E-04	mg/m^3	n/a	1.5E-06	3.7E-06	3.7E-06	mg/m^3	n/a	2.5E-01	2.5E-01	8.4E-02	$1/(\mu g/m^3)$	1.6E-03

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
COPC = chemical of potential concern
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
$\mu g/m^3$= microgram per cubic meter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 7.11.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	1.9E-02	mg/kg/day	NA	NA	NA	5.4E-02	mg/kg/day	1.0E+00	mg/kg/day	5.4E-02
				Antimony	7.3E+01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	2.9E-04	mg/kg/day	4.0E-04	mg/kg/day	7.1E-01
				Arsenic	4.6E+01	mg/kg	3.8E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.7E-05	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.6E-01
				Barium	1.7E+02	mg/kg	2.3E-04	mg/kg/day	NA	NA	NA	6.6E-04	mg/kg/day	2.0E-01	mg/kg/day	3.3E-03
				Beryllium	1.2E+00	mg/kg	1.7E-06	mg/kg/day	NA	NA	NA	4.8E-06	mg/kg/day	2.0E-03	mg/kg/day	2.4E-03
				Cadmium (non-water)	3.6E+02	mg/kg	5.0E-04	mg/kg/day	NA	NA	NA	1.4E-03	mg/kg/day	1.0E-03	mg/kg/day	1.4E+00
				Chromium (trivalent)	3.3E+01	mg/kg	4.7E-05	mg/kg/day	NA	NA	NA	1.3E-04	mg/kg/day	1.5E+00	mg/kg/day	8.7E-05
				Cobalt	3.8E+01	mg/kg	5.3E-05	mg/kg/day	NA	NA	NA	1.5E-04	mg/kg/day	3.0E-04	mg/kg/day	4.9E-01
				Copper	8.6E+01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	3.4E-04	mg/kg/day	4.0E-02	mg/kg/day	8.4E-03
				Iron	9.3E+04	mg/kg	1.3E-01	mg/kg/day	NA	NA	NA	3.7E-01	mg/kg/day	7.0E-01	mg/kg/day	5.2E-01
				Lead	1.1E+03	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	4.3E-03	mg/kg/day	NA	NA	NA
				Lithium	4.1E+01	mg/kg	5.7E-05	mg/kg/day	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-03	mg/kg/day	8.0E-02
				Manganese (non-diet)	9.0E+02	mg/kg	1.3E-03	mg/kg/day	NA	NA	NA	3.5E-03	mg/kg/day	2.4E-02	mg/kg/day	1.5E-01
				Mercury (HgCl)	2.4E-01	mg/kg	3.3E-07	mg/kg/day	NA	NA	NA	9.2E-07	mg/kg/day	3.0E-04	mg/kg/day	3.1E-03
				Molybdenum	1.0E+02	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	3.9E-04	mg/kg/day	5.0E-03	mg/kg/day	7.8E-02
				Nickel	4.8E+01	mg/kg	6.7E-05	mg/kg/day	NA	NA	NA	1.9E-04	mg/kg/day	2.0E-02	mg/kg/day	9.3E-03
				Phosphorus	1.1E+03	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	4.3E-03	mg/kg/day	NA	NA	NA
				Selenium	5.2E+00	mg/kg	7.2E-06	mg/kg/day	NA	NA	NA	2.0E-05	mg/kg/day	5.0E-03	mg/kg/day	4.0E-03
				Silica (as SIO2)	4.7E+03	mg/kg	6.6E-03	mg/kg/day	NA	NA	NA	1.8E-02	mg/kg/day	NA	NA	NA
				Silver	9.2E-01	mg/kg	1.3E-06	mg/kg/day	NA	NA	NA	3.6E-06	mg/kg/day	5.0E-03	mg/kg/day	7.2E-04
				Strontium	8.9E+01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	3.5E-04	mg/kg/day	6.0E-01	mg/kg/day	5.8E-04
				Thallium	9.8E-01	mg/kg	1.4E-06	mg/kg/day	NA	NA	NA	3.8E-06	mg/kg/day	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	8.7E-05	mg/kg/day	NA	NA	NA	2.4E-04	mg/kg/day	5.0E-03	mg/kg/day	4.9E-02
				Zinc	2.1E+04	mg/kg	3.0E-02	mg/kg/day	NA	NA	NA	8.4E-02	mg/kg/day	3.0E-01	mg/kg/day	2.8E-01
			Exp. Route Total								5.7E-05					4.2E+00

TABLE 7.11.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+01	mg/kg	9.4E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.1E-05	2.6E-05	mg/kg/day	3.0E-04	mg/kg/day	8.8E-02
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	3.6E+02	mg/kg	2.4E-06	mg/kg/day	NA	NA	NA	6.9E-06	mg/kg/day	2.5E-05	mg/kg/day	2.7E-01
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								5.1E-05					3.6E-01
		Exposure Point Total									1.1E-04					4.6E+00
	Exposure Medium Total										1.1E-04					4.6E+00
Medium Total											1.1E-04					4.6E+00

TABLE 7.11.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Ingestion	Aluminum	4.7E-01	mg/L	9.1E-04	mg/kg/day	NA	NA	NA	2.5E-03	mg/kg/day	1.0E+00	mg/kg/day	2.5E-03
				Antimony	5.7E-04	mg/L	1.1E-06	mg/kg/day	NA	NA	NA	3.1E-06	mg/kg/day	4.0E-04	mg/kg/day	7.7E-03
				Arsenic	3.4E-02	mg/L	6.5E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	9.8E-05	1.8E-04	mg/kg/day	3.0E-04	mg/kg/day	6.1E-01
				Barium	5.0E-02	mg/L	9.6E-05	mg/kg/day	NA	NA	NA	2.7E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Beryllium	2.8E-04	mg/L	5.4E-07	mg/kg/day	NA	NA	NA	1.5E-06	mg/kg/day	2.0E-03	mg/kg/day	7.6E-04
				Cadmium (water)	1.6E-02	mg/L	3.1E-05	mg/kg/day	NA	NA	NA	8.8E-05	mg/kg/day	5.0E-04	mg/kg/day	1.8E-01
				Chromium (hexavalent)	3.7E-03	mg/L	7.2E-06	mg/kg/day	5.0E-01	1/(mg/kg/day)	3.6E-06	2.0E-05	mg/kg/day	3.0E-03	mg/kg/day	6.7E-03
				Cobalt	3.2E-02	mg/L	6.1E-05	mg/kg/day	NA	NA	NA	1.7E-04	mg/kg/day	3.0E-04	mg/kg/day	5.7E-01
				Copper	6.1E-03	mg/L	1.2E-05	mg/kg/day	NA	NA	NA	3.3E-05	mg/kg/day	4.0E-02	mg/kg/day	8.3E-04
				Iron	5.1E+01	mg/L	9.9E-02	mg/kg/day	NA	NA	NA	2.8E-01	mg/kg/day	7.0E-01	mg/kg/day	4.0E-01
				Lead	3.7E-02	mg/L	7.1E-05	mg/kg/day	NA	NA	NA	2.0E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	3.1E-03	mg/kg/day	NA	NA	NA	8.7E-03	mg/kg/day	2.4E-02	mg/kg/day	3.6E-01
				Mercury (HgCl)	5.8E-05	mg/L	1.1E-07	mg/kg/day	NA	NA	NA	3.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Molybdenum	1.0E-02	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	5.4E-05	mg/kg/day	5.0E-03	mg/kg/day	1.1E-02
				Nickel	3.3E-01	mg/L	6.4E-04	mg/kg/day	NA	NA	NA	1.8E-03	mg/kg/day	2.0E-02	mg/kg/day	9.0E-02
				Selenium	8.1E-04	mg/L	1.6E-06	mg/kg/day	NA	NA	NA	4.4E-06	mg/kg/day	5.0E-03	mg/kg/day	8.7E-04
				Silica (as SIO2)	1.6E+01	mg/L	3.0E-02	mg/kg/day	NA	NA	NA	8.4E-02	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	4.3E-07	mg/kg/day	NA	NA	NA	1.2E-06	mg/kg/day	5.0E-03	mg/kg/day	2.4E-04
				Thallium	2.3E-04	mg/L	4.4E-07	mg/kg/day	NA	NA	NA	1.2E-06	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	1.6E-05	mg/kg/day	NA	NA	NA	4.5E-05	mg/kg/day	5.0E-03	mg/kg/day	8.9E-03
				Zinc	6.3E+00	mg/L	1.2E-02	mg/kg/day	NA	NA	NA	3.4E-02	mg/kg/day	3.0E-01	mg/kg/day	1.1E-01
			Exp. Route Total								1.0E-04					2.4E+00

TABLE 7.11.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	1.9E-04	mg/kg/day	NA	NA	NA	5.4E-04	mg/kg/day	1.0E+00	mg/kg/day	5.4E-04
				Antimony	5.7E-04	mg/L	2.3E-07	mg/kg/day	NA	NA	NA	6.6E-07	mg/kg/day	6.0E-05	mg/kg/day	1.1E-02
				Arsenic	3.4E-02	mg/L	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	3.9E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	5.0E-02	mg/L	2.1E-05	mg/kg/day	NA	NA	NA	5.8E-05	mg/kg/day	1.4E-02	mg/kg/day	4.1E-03
				Beryllium	2.8E-04	mg/L	1.2E-07	mg/kg/day	NA	NA	NA	3.2E-07	mg/kg/day	1.4E-05	mg/kg/day	2.3E-02
				Cadmium (water)	1.6E-02	mg/L	6.7E-06	mg/kg/day	NA	NA	NA	1.9E-05	mg/kg/day	2.5E-05	mg/kg/day	7.5E-01
				Chromium (hexavalent)	3.7E-03	mg/L	3.1E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	6.2E-05	8.6E-06	mg/kg/day	7.5E-05	mg/kg/day	1.2E-01
				Cobalt	3.2E-02	mg/L	5.2E-06	mg/kg/day	NA	NA	NA	1.5E-05	mg/kg/day	3.0E-04	mg/kg/day	4.9E-02
				Copper	6.1E-03	mg/L	2.5E-06	mg/kg/day	NA	NA	NA	7.1E-06	mg/kg/day	4.0E-02	mg/kg/day	1.8E-04
				Iron	5.1E+01	mg/L	2.1E-02	mg/kg/day	NA	NA	NA	5.9E-02	mg/kg/day	7.0E-01	mg/kg/day	8.5E-02
				Lead	3.7E-02	mg/L	1.5E-06	mg/kg/day	NA	NA	NA	4.3E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	6.7E-04	mg/kg/day	NA	NA	NA	1.9E-03	mg/kg/day	9.6E-04	mg/kg/day	1.9E+00
				Mercury (HgCl)	5.8E-05	mg/L	2.4E-08	mg/kg/day	NA	NA	NA	6.7E-08	mg/kg/day	2.1E-05	mg/kg/day	3.2E-03
				Molybdenum	1.0E-02	mg/L	4.1E-06	mg/kg/day	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.3E-03
				Nickel	3.3E-01	mg/L	2.8E-05	mg/kg/day	NA	NA	NA	7.7E-05	mg/kg/day	8.0E-04	mg/kg/day	9.6E-02
				Selenium	8.1E-04	mg/L	3.3E-07	mg/kg/day	NA	NA	NA	9.3E-07	mg/kg/day	5.0E-03	mg/kg/day	1.9E-04
				Silica (as SIO2)	1.6E+01	mg/L	6.4E-03	mg/kg/day	NA	NA	NA	1.8E-02	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	5.5E-08	mg/kg/day	NA	NA	NA	1.5E-07	mg/kg/day	2.0E-04	mg/kg/day	7.7E-04
				Thallium	2.3E-04	mg/L	9.4E-08	mg/kg/day	NA	NA	NA	2.6E-07	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	3.4E-06	mg/kg/day	NA	NA	NA	9.5E-06	mg/kg/day	1.3E-04	mg/kg/day	7.3E-02
				Zinc	6.3E+00	mg/L	1.6E-03	mg/kg/day	NA	NA	NA	4.4E-03	mg/kg/day	3.0E-01	mg/kg/day	1.5E-02
			Exp. Route Total								8.3E-05					3.3E+00
		Exposure Point Total									1.8E-04					5.7E+00
	Exposure Medium Total										1.8E-04					5.7E+00
Medium Total											1.8E-04					5.7E+00
Receptor Total (Sediment + Surface Water)											3E-04					1E+01

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.11.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Exposure Scenario: Work Activities

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)
Aluminum	4.7E-01	1.0E-03	6.0	2.8E-06
Antimony	5.7E-04	1.0E-03	6.0	3.4E-09
Arsenic	3.4E-02	1.0E-03	6.0	2.0E-07
Barium	5.0E-02	1.0E-03	6.0	3.0E-07
Beryllium	2.8E-04	1.0E-03	6.0	1.7E-09
Cadmium (water)	1.6E-02	1.0E-03	6.0	9.8E-08
Chromium (hexavalent)	3.7E-03	2.0E-03	6.0	4.5E-08
Cobalt	3.2E-02	4.0E-04	6.0	7.6E-08
Copper	6.1E-03	1.0E-03	6.0	3.7E-08
Iron	5.1E+01	1.0E-03	6.0	3.1E-04
Lead	3.7E-02	1.0E-04	6.0	2.2E-08
Manganese (non-diet)	1.6E+00	1.0E-03	6.0	9.7E-06
Mercury (HgCl)	5.8E-05	1.0E-03	6.0	3.5E-10
Molybdenum	1.0E-02	1.0E-03	6.0	6.0E-08
Nickel	3.3E-01	2.0E-04	6.0	4.0E-07
Selenium	8.1E-04	1.0E-03	6.0	4.9E-09
Silica (as SIO2)	1.6E+01	1.0E-03	6.0	9.3E-05
Silver	2.2E-04	6.0E-04	6.0	8.1E-10
Thallium	2.3E-04	1.0E-03	6.0	1.4E-09
Vanadium	8.2E-03	1.0E-03	6.0	4.9E-08
Zinc	6.3E+00	6.0E-04	6.0	2.3E-05

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	1.0E+00	mg/kg/day	1.3E-03
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	7.0E-06	mg/kg/day	4.0E-04	mg/kg/day	1.8E-02
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	3.0E-04	mg/kg/day	8.8E-03
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.0E-01	mg/kg/day	8.1E-05
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	2.0E-03	mg/kg/day	5.9E-05
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	1.0E-03	mg/kg/day	3.4E-02
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	1.5E+00	mg/kg/day	2.1E-06
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	8.3E-06	mg/kg/day	4.0E-02	mg/kg/day	2.1E-04
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	9.0E-03	mg/kg/day	7.0E-01	mg/kg/day	1.3E-02
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	2.0E-03	mg/kg/day	2.0E-03
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	8.7E-05	mg/kg/day	2.4E-02	mg/kg/day	3.6E-03
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-08	mg/kg/day	3.0E-04	mg/kg/day	7.5E-05
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	9.6E-06	mg/kg/day	5.0E-03	mg/kg/day	1.9E-03
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	4.6E-06	mg/kg/day	2.0E-02	mg/kg/day	2.3E-04
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-07	mg/kg/day	5.0E-03	mg/kg/day	9.9E-05
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	8.8E-08	mg/kg/day	5.0E-03	mg/kg/day	1.8E-05
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-06	mg/kg/day	6.0E-01	mg/kg/day	1.4E-05
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	9.4E-08	mg/kg/day	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	6.0E-06	mg/kg/day	5.0E-03	mg/kg/day	1.2E-03
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	3.0E-01	mg/kg/day	6.8E-03
			Exp. Route Total								NA					1.0E-01

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	5.5E-07	mg/kg/day	3.0E-04	mg/kg/day	1.8E-03
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	2.5E-05	mg/kg/day	5.8E-03
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.6E-03
		Exposure Point Total									NA					1.1E-01
	Exposure Medium Total										NA					1.1E-01
Medium Total											NA					1.1E-01

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	1.0E+00	mg/kg/day	4.2E-05
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	5.0E-08	mg/kg/day	4.0E-04	mg/kg/day	1.3E-04
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	3.0E-06	mg/kg/day	3.0E-04	mg/kg/day	1.0E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	4.4E-06	mg/kg/day	2.0E-01	mg/kg/day	2.2E-05
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	2.5E-08	mg/kg/day	2.0E-03	mg/kg/day	1.2E-05
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	5.0E-04	mg/kg/day	2.9E-03
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	3.3E-07	mg/kg/day	3.0E-03	mg/kg/day	1.1E-04
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	3.0E-04	mg/kg/day	9.3E-03
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	5.4E-07	mg/kg/day	4.0E-02	mg/kg/day	1.4E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	4.5E-03	mg/kg/day	7.0E-01	mg/kg/day	6.5E-03
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	3.3E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	2.4E-02	mg/kg/day	5.9E-03
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	5.1E-09	mg/kg/day	3.0E-04	mg/kg/day	1.7E-05
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	8.8E-07	mg/kg/day	5.0E-03	mg/kg/day	1.8E-04
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	2.0E-02	mg/kg/day	1.5E-03
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	7.1E-08	mg/kg/day	5.0E-03	mg/kg/day	1.4E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	2.0E-08	mg/kg/day	5.0E-03	mg/kg/day	3.9E-06
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	2.0E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	7.3E-07	mg/kg/day	5.0E-03	mg/kg/day	1.5E-04
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	5.6E-04	mg/kg/day	3.0E-01	mg/kg/day	1.9E-03
			Exp. Route Total								NA					3.9E-02

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	8.9E-06	mg/kg/day	1.0E+00	mg/kg/day	8.9E-06
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.1E-08	mg/kg/day	6.0E-05	mg/kg/day	1.8E-04
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	6.4E-07	mg/kg/day	3.0E-04	mg/kg/day	2.1E-03
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	9.4E-07	mg/kg/day	1.4E-02	mg/kg/day	6.7E-05
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	5.3E-09	mg/kg/day	1.4E-05	mg/kg/day	3.8E-04
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	3.1E-07	mg/kg/day	2.5E-05	mg/kg/day	1.2E-02
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	7.5E-05	mg/kg/day	1.9E-03
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	3.0E-04	mg/kg/day	7.9E-04
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	4.0E-02	mg/kg/day	2.9E-06
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	9.7E-04	mg/kg/day	7.0E-01	mg/kg/day	1.4E-03
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	6.9E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	9.6E-04	mg/kg/day	3.2E-02
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.1E-09	mg/kg/day	2.1E-05	mg/kg/day	5.2E-05
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	5.0E-03	mg/kg/day	3.8E-05
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	8.0E-04	mg/kg/day	1.6E-03
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	5.0E-03	mg/kg/day	3.1E-06
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	2.5E-09	mg/kg/day	2.0E-04	mg/kg/day	1.3E-05
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	4.3E-09	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	1.3E-04	mg/kg/day	1.2E-03
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	7.1E-05	mg/kg/day	3.0E-01	mg/kg/day	2.4E-04
			Exp. Route Total								NA					5.4E-02
		Exposure Point Total									NA					9.3E-02

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	5.4E-06	mg/kg/day	1.0E+00	mg/kg/day	5.4E-06
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	6.6E-09	mg/kg/day	6.0E-05	mg/kg/day	1.1E-04
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	3.9E-07	mg/kg/day	3.0E-04	mg/kg/day	1.3E-03
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	5.8E-07	mg/kg/day	1.4E-02	mg/kg/day	4.1E-05
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	3.2E-09	mg/kg/day	1.4E-05	mg/kg/day	2.3E-04
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	2.5E-05	mg/kg/day	7.5E-03
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	8.7E-08	mg/kg/day	7.5E-05	mg/kg/day	1.2E-03
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	3.0E-04	mg/kg/day	4.9E-04
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	7.1E-08	mg/kg/day	4.0E-02	mg/kg/day	1.8E-06
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	7.0E-01	mg/kg/day	8.5E-04
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	4.3E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	9.6E-04	mg/kg/day	1.9E-02
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	6.7E-10	mg/kg/day	2.1E-05	mg/kg/day	3.2E-05
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	5.0E-03	mg/kg/day	2.3E-05
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	7.7E-07	mg/kg/day	8.0E-04	mg/kg/day	9.7E-04
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	9.4E-09	mg/kg/day	5.0E-03	mg/kg/day	1.9E-06
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	1.6E-09	mg/kg/day	2.0E-04	mg/kg/day	7.8E-06
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	2.6E-09	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	9.5E-08	mg/kg/day	1.3E-04	mg/kg/day	7.3E-04
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-01	mg/kg/day	1.5E-04
			Exp. Route Total								NA					3.3E-02
		Exposure Point Total									NA					3.3E-02

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	1.0E+00	mg/kg/day	1.4E-02
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	4.0E-04	mg/kg/day	4.3E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	3.0E-04	mg/kg/day	3.4E+00
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.5E-03
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	8.4E-06	mg/kg/day	2.0E-03	mg/kg/day	4.2E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	5.0E-04	mg/kg/day	9.8E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	3.0E-03	mg/kg/day	3.7E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	9.5E-04	mg/kg/day	3.0E-04	mg/kg/day	3.2E+00
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	4.0E-02	mg/kg/day	4.6E-03
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.5E+00	mg/kg/day	7.0E-01	mg/kg/day	2.2E+00
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	4.8E-02	mg/kg/day	2.4E-02	mg/kg/day	2.0E+00
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	3.0E-04	mg/kg/day	5.8E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	5.0E-03	mg/kg/day	6.0E-02
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.0E-02	mg/kg/day	2.0E-02	mg/kg/day	5.0E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	5.0E-03	mg/kg/day	4.9E-03
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	4.7E-01	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	6.7E-06	mg/kg/day	5.0E-03	mg/kg/day	1.3E-03
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	6.8E-06	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	5.0E-03	mg/kg/day	4.9E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	1.9E-01	mg/kg/day	3.0E-01	mg/kg/day	6.3E-01
			Exp. Route Total								NA					1.3E+01

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	1.0E+00	mg/kg/day	7.9E-05
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	9.5E-08	mg/kg/day	6.0E-05	mg/kg/day	1.6E-03
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	5.7E-06	mg/kg/day	3.0E-04	mg/kg/day	1.9E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	8.4E-06	mg/kg/day	1.4E-02	mg/kg/day	6.0E-04
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	4.7E-08	mg/kg/day	1.4E-05	mg/kg/day	3.3E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	2.5E-05	mg/kg/day	1.1E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	7.5E-05	mg/kg/day	1.7E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.1E-06	mg/kg/day	3.0E-04	mg/kg/day	7.0E-03
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	4.0E-02	mg/kg/day	2.6E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	8.6E-03	mg/kg/day	7.0E-01	mg/kg/day	1.2E-02
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	6.2E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	9.6E-04	mg/kg/day	2.8E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	9.6E-09	mg/kg/day	2.1E-05	mg/kg/day	4.6E-04
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	5.0E-03	mg/kg/day	3.3E-04
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	8.0E-04	mg/kg/day	1.4E-02
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	5.0E-03	mg/kg/day	2.7E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	2.2E-08	mg/kg/day	2.0E-04	mg/kg/day	1.1E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	3.8E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	1.3E-04	mg/kg/day	1.1E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	6.3E-04	mg/kg/day	3.0E-01	mg/kg/day	2.1E-03
			Exp. Route Total								NA					4.8E-01
		Exposure Point Total									NA					1.4E+01
	Exposure Medium Total (Swimming + Potable Use)										NA					1.4E+01
	Exposure Medium Total (Wading + Potable Use)										NA					1.4E+01
Medium Total (Swimming + Potable Use)											NA					1.4E+01
Medium Total (Wading + Potable Use)											NA					1.4E+01

TABLE 7.12.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-04	mg/kg/day	5.1E-01
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.1E-02
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	9.9E-06	mg/kg/day	2.0E-03	mg/kg/day	4.9E-03
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.0E-03	mg/kg/day	3.1E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	1.9E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	7.0E-01	mg/kg/day	4.5E-03
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	1.4E-01	mg/kg/day	1.2E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	1.0E-04	mg/kg/day	4.2E-01
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.6E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	3.0E-01	mg/kg/day	2.9E-02
			Exp. Route Total								NA					1.5E+00
		Exposure Point Total									NA					1.5E+00
	Exposure Medium Total										NA					1.5E+00
Medium Total											NA					1.5E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					2E+01
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					2E+01

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.12.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	4.7E-01	1.0E-03	1.0	4.7E-07	1.0	4.7E-07	9.8E-02
Antimony	5.7E-04	1.0E-03	1.0	5.7E-10	1.0	5.7E-10	1.2E-04
Arsenic	3.4E-02	1.0E-03	1.0	3.4E-08	1.0	3.4E-08	7.1E-03
Barium	5.0E-02	1.0E-03	1.0	5.0E-08	1.0	5.0E-08	1.0E-02
Beryllium	2.8E-04	1.0E-03	1.0	2.8E-10	1.0	2.8E-10	5.8E-05
Cadmium (water)	1.6E-02	1.0E-03	1.0	1.6E-08	1.0	1.6E-08	3.4E-03
Chromium (hexavalent)	3.7E-03	2.0E-03	1.0	7.5E-09	1.0	7.5E-09	1.6E-03
Cobalt	3.2E-02	4.0E-04	1.0	1.3E-08	1.0	1.3E-08	2.6E-03
Copper	6.1E-03	1.0E-03	1.0	6.1E-09	1.0	6.1E-09	1.3E-03
Iron	5.1E+01	1.0E-03	1.0	5.1E-05	1.0	5.1E-05	1.1E+01
Lead	3.7E-02	1.0E-04	1.0	3.7E-09	1.0	3.7E-09	7.7E-04
Manganese (non-diet)	1.6E+00	1.0E-03	1.0	1.6E-06	1.0	1.6E-06	3.4E-01
Mercury (HgCl)	5.8E-05	1.0E-03	1.0	5.8E-11	1.0	5.8E-11	1.2E-05
Molybdenum	1.0E-02	1.0E-03	1.0	1.0E-08	1.0	1.0E-08	2.1E-03
Nickel	3.3E-01	2.0E-04	1.0	6.7E-08	1.0	6.7E-08	1.4E-02
Selenium	8.1E-04	1.0E-03	1.0	8.1E-10	1.0	8.1E-10	1.7E-04
Silica (as SIO2)	1.6E+01	1.0E-03	1.0	1.6E-05	1.0	1.6E-05	3.3E+00
Silver	2.2E-04	6.0E-04	1.0	1.3E-10	1.0	1.3E-10	2.8E-05
Thallium	2.3E-04	1.0E-03	1.0	2.3E-10	1.0	2.3E-10	4.7E-05
Vanadium	8.2E-03	1.0E-03	1.0	8.2E-09	1.0	8.2E-09	1.7E-03
Zinc	6.3E+00	6.0E-04	1.0	3.8E-06	1.0	3.8E-06	7.9E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.12.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Wading

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	6,032	2,373
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	4.7E-01	1.0E-03	2.0	9.4E-07	2.0	9.4E-07	6.5E-02
Antimony	5.7E-04	1.0E-03	2.0	1.1E-09	2.0	1.1E-09	7.8E-05
Arsenic	3.4E-02	1.0E-03	2.0	6.8E-08	2.0	6.8E-08	4.7E-03
Barium	5.0E-02	1.0E-03	2.0	1.0E-07	2.0	1.0E-07	6.9E-03
Beryllium	2.8E-04	1.0E-03	2.0	5.6E-10	2.0	5.6E-10	3.9E-05
Cadmium (water)	1.6E-02	1.0E-03	2.0	3.3E-08	2.0	3.3E-08	2.2E-03
Chromium (hexavalent)	3.7E-03	2.0E-03	2.0	1.5E-08	2.0	1.5E-08	1.0E-03
Cobalt	3.2E-02	4.0E-04	2.0	2.5E-08	2.0	2.5E-08	1.7E-03
Copper	6.1E-03	1.0E-03	2.0	1.2E-08	2.0	1.2E-08	8.4E-04
Iron	5.1E+01	1.0E-03	2.0	1.0E-04	2.0	1.0E-04	7.1E+00
Lead	3.7E-02	1.0E-04	2.0	7.4E-09	2.0	7.4E-09	5.1E-04
Manganese (non-diet)	1.6E+00	1.0E-03	2.0	3.2E-06	2.0	3.2E-06	2.2E-01
Mercury (HgCl)	5.8E-05	1.0E-03	2.0	1.2E-10	2.0	1.2E-10	7.9E-06
Molybdenum	1.0E-02	1.0E-03	2.0	2.0E-08	2.0	2.0E-08	1.4E-03
Nickel	3.3E-01	2.0E-04	2.0	1.3E-07	2.0	1.3E-07	9.2E-03
Selenium	8.1E-04	1.0E-03	2.0	1.6E-09	2.0	1.6E-09	1.1E-04
Silica (as SIO2)	1.6E+01	1.0E-03	2.0	3.1E-05	2.0	3.1E-05	2.1E+00
Silver	2.2E-04	6.0E-04	2.0	2.7E-10	2.0	2.7E-10	1.8E-05
Thallium	2.3E-04	1.0E-03	2.0	4.5E-10	2.0	4.5E-10	3.1E-05
Vanadium	8.2E-03	1.0E-03	2.0	1.6E-08	2.0	1.6E-08	1.1E-03
Zinc	6.3E+00	6.0E-04	2.0	7.6E-06	2.0	7.6E-06	5.2E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.12.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	350	350
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	4.7E-01	1.0E-03	0.71	3.3E-07	0.54	2.5E-07	8.0E-01
Antimony	5.7E-04	1.0E-03	0.71	4.0E-10	0.54	3.1E-10	9.7E-04
Arsenic	3.4E-02	1.0E-03	0.71	2.4E-08	0.54	1.8E-08	5.8E-02
Barium	5.0E-02	1.0E-03	0.71	3.6E-08	0.54	2.7E-08	8.5E-02
Beryllium	2.8E-04	1.0E-03	0.71	2.0E-10	0.54	1.5E-10	4.8E-04
Cadmium (water)	1.6E-02	1.0E-03	0.71	1.2E-08	0.54	8.8E-09	2.8E-02
Chromium (hexavalent)	3.7E-03	2.0E-03	0.71	5.3E-09	0.54	4.0E-09	1.3E-02
Cobalt	3.2E-02	4.0E-04	0.71	9.0E-09	0.54	6.8E-09	2.2E-02
Copper	6.1E-03	1.0E-03	0.71	4.4E-09	0.54	3.3E-09	1.0E-02
Iron	5.1E+01	1.0E-03	0.71	3.6E-05	0.54	2.8E-05	8.7E+01
Lead	3.7E-02	1.0E-04	0.71	2.6E-09	0.54	2.0E-09	6.3E-03
Manganese (non-diet)	1.6E+00	1.0E-03	0.71	1.1E-06	0.54	8.7E-07	2.8E+00
Mercury (HgCl)	5.8E-05	1.0E-03	0.71	4.1E-11	0.54	3.1E-11	9.8E-05
Molybdenum	1.0E-02	1.0E-03	0.71	7.1E-09	0.54	5.4E-09	1.7E-02
Nickel	3.3E-01	2.0E-04	0.71	4.7E-08	0.54	3.6E-08	1.1E-01
Selenium	8.1E-04	1.0E-03	0.71	5.7E-10	0.54	4.4E-10	1.4E-03
Silica (as SIO2)	1.6E+01	1.0E-03	0.71	1.1E-05	0.54	8.4E-06	2.7E+01
Silver	2.2E-04	6.0E-04	0.71	9.5E-11	0.54	7.3E-11	2.3E-04
Thallium	2.3E-04	1.0E-03	0.71	1.6E-10	0.54	1.2E-10	3.9E-04
Vanadium	8.2E-03	1.0E-03	0.71	5.9E-09	0.54	4.4E-09	1.4E-02
Zinc	6.3E+00	6.0E-04	0.71	2.7E-06	0.54	2.0E-06	6.4E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	1.0E+00	mg/kg/day	1.4E-02
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	7.5E-05	mg/kg/day	4.0E-04	mg/kg/day	1.9E-01
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	3.0E-04	mg/kg/day	9.3E-02
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-01	mg/kg/day	8.6E-04
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	2.0E-03	mg/kg/day	6.3E-04
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	1.0E-03	mg/kg/day	3.6E-01
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	1.5E+00	mg/kg/day	2.3E-05
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	8.8E-05	mg/kg/day	4.0E-02	mg/kg/day	2.2E-03
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	9.6E-02	mg/kg/day	7.0E-01	mg/kg/day	1.4E-01
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	2.0E-03	mg/kg/day	2.1E-02
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	9.2E-04	mg/kg/day	2.4E-02	mg/kg/day	3.9E-02
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	3.0E-04	mg/kg/day	8.0E-04
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	5.0E-03	mg/kg/day	2.0E-02
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	4.9E-05	mg/kg/day	2.0E-02	mg/kg/day	2.4E-03
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	5.3E-06	mg/kg/day	5.0E-03	mg/kg/day	1.1E-03
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	9.4E-07	mg/kg/day	5.0E-03	mg/kg/day	1.9E-04
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	9.1E-05	mg/kg/day	6.0E-01	mg/kg/day	1.5E-04
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	5.0E-03	mg/kg/day	1.3E-02
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	3.0E-01	mg/kg/day	7.3E-02
			Exp. Route Total								NA					1.1E+00

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-06	mg/kg/day	3.0E-04	mg/kg/day	1.1E-02
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	3.6E+02	mg/kg	NA	NA	NA	NA	NA	8.7E-07	mg/kg/day	2.5E-05	mg/kg/day	3.5E-02
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					4.6E-02
		Exposure Point Total									NA					1.1E+00
	Exposure Medium Total										NA					1.1E+00
Medium Total											NA					1.1E+00

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	1.0E+00	mg/kg/day	2.9E-04
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	3.5E-07	mg/kg/day	4.0E-04	mg/kg/day	8.7E-04
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	3.0E-04	mg/kg/day	6.9E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	2.0E-01	mg/kg/day	1.5E-04
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	2.0E-03	mg/kg/day	8.6E-05
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	5.0E-04	mg/kg/day	2.0E-02
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	3.0E-03	mg/kg/day	7.7E-04
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.5E-02
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	3.8E-06	mg/kg/day	4.0E-02	mg/kg/day	9.4E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	3.1E-02	mg/kg/day	7.0E-01	mg/kg/day	4.5E-02
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	9.9E-04	mg/kg/day	2.4E-02	mg/kg/day	4.1E-02
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	3.5E-08	mg/kg/day	3.0E-04	mg/kg/day	1.2E-04
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	6.1E-06	mg/kg/day	5.0E-03	mg/kg/day	1.2E-03
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	2.0E-02	mg/kg/day	1.0E-02
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	5.0E-07	mg/kg/day	5.0E-03	mg/kg/day	9.9E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	9.6E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	5.0E-03	mg/kg/day	2.7E-05
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	5.0E-03	mg/kg/day	1.0E-03
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	3.9E-03	mg/kg/day	3.0E-01	mg/kg/day	1.3E-02
			Exp. Route Total								NA					2.7E-01

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	1.0E+00	mg/kg/day	1.5E-05
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.8E-08	mg/kg/day	6.0E-05	mg/kg/day	3.1E-04
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	3.0E-04	mg/kg/day	3.7E-03
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	1.4E-02	mg/kg/day	1.2E-04
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	9.1E-09	mg/kg/day	1.4E-05	mg/kg/day	6.5E-04
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	5.3E-07	mg/kg/day	2.5E-05	mg/kg/day	2.1E-02
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	7.5E-05	mg/kg/day	3.2E-03
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	4.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.4E-03
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	4.0E-02	mg/kg/day	5.0E-06
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	7.0E-01	mg/kg/day	2.4E-03
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	9.6E-04	mg/kg/day	5.5E-02
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.9E-09	mg/kg/day	2.1E-05	mg/kg/day	8.9E-05
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	3.3E-07	mg/kg/day	5.0E-03	mg/kg/day	6.5E-05
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	2.2E-06	mg/kg/day	8.0E-04	mg/kg/day	2.7E-03
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	2.6E-08	mg/kg/day	5.0E-03	mg/kg/day	5.3E-06
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	4.4E-09	mg/kg/day	2.0E-04	mg/kg/day	2.2E-05
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	7.4E-09	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	2.7E-07	mg/kg/day	1.3E-04	mg/kg/day	2.1E-03
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	3.0E-01	mg/kg/day	4.1E-04
			Exp. Route Total								NA					9.3E-02
		Exposure Point Total									NA					3.6E-01

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	1.0E+00	mg/kg/day	1.1E-05
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.4E-08	mg/kg/day	6.0E-05	mg/kg/day	2.3E-04
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	8.2E-07	mg/kg/day	3.0E-04	mg/kg/day	2.7E-03
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	1.4E-02	mg/kg/day	8.7E-05
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	6.8E-09	mg/kg/day	1.4E-05	mg/kg/day	4.9E-04
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	4.0E-07	mg/kg/day	2.5E-05	mg/kg/day	1.6E-02
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	7.5E-05	mg/kg/day	2.4E-03
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	3.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	4.0E-02	mg/kg/day	3.7E-06
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	7.0E-01	mg/kg/day	1.8E-03
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	8.9E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	9.6E-04	mg/kg/day	4.1E-02
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.4E-09	mg/kg/day	2.1E-05	mg/kg/day	6.7E-05
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	5.0E-03	mg/kg/day	4.9E-05
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	8.0E-04	mg/kg/day	2.0E-03
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	2.0E-08	mg/kg/day	5.0E-03	mg/kg/day	3.9E-06
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	3.3E-09	mg/kg/day	2.0E-04	mg/kg/day	1.6E-05
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	5.5E-09	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	1.3E-04	mg/kg/day	1.5E-03
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	9.2E-05	mg/kg/day	3.0E-01	mg/kg/day	3.1E-04
			Exp. Route Total								NA					7.0E-02
		Exposure Point Total									NA					7.0E-02

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	1.0E+00	mg/kg/day	2.3E-02
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	4.0E-04	mg/kg/day	7.1E-02
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	3.0E-04	mg/kg/day	5.6E+00
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	2.0E-01	mg/kg/day	1.2E-02
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-03	mg/kg/day	7.0E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	8.1E-04	mg/kg/day	5.0E-04	mg/kg/day	1.6E+00
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	3.0E-03	mg/kg/day	6.2E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	3.0E-04	mg/kg/day	5.3E+00
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-02	mg/kg/day	7.6E-03
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	2.6E+00	mg/kg/day	7.0E-01	mg/kg/day	3.7E+00
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	8.1E-02	mg/kg/day	2.4E-02	mg/kg/day	3.4E+00
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	3.0E-04	mg/kg/day	9.6E-03
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	5.0E-03	mg/kg/day	1.0E-01
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.7E-02	mg/kg/day	2.0E-02	mg/kg/day	8.3E-01
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	4.0E-05	mg/kg/day	5.0E-03	mg/kg/day	8.1E-03
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	7.8E-01	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	5.0E-03	mg/kg/day	2.2E-03
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	5.0E-03	mg/kg/day	8.2E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	3.0E-01	mg/kg/day	1.0E+00
			Exp. Route Total								NA					2.2E+01

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	1.0E+00	mg/kg/day	1.0E-04
				Antimony	5.7E-04	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	6.0E-05	mg/kg/day	2.1E-03
				Arsenic	3.4E-02	mg/L	NA	NA	NA	NA	NA	7.4E-06	mg/kg/day	3.0E-04	mg/kg/day	2.5E-02
				Barium	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	1.4E-02	mg/kg/day	7.8E-04
				Beryllium	2.8E-04	mg/L	NA	NA	NA	NA	NA	6.2E-08	mg/kg/day	1.4E-05	mg/kg/day	4.4E-03
				Cadmium (water)	1.6E-02	mg/L	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	2.5E-05	mg/kg/day	1.4E-01
				Chromium (hexavalent)	3.7E-03	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	7.5E-05	mg/kg/day	2.2E-02
				Cobalt	3.2E-02	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	3.0E-04	mg/kg/day	9.3E-03
				Copper	6.1E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	4.0E-02	mg/kg/day	3.4E-05
				Iron	5.1E+01	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	7.0E-01	mg/kg/day	1.6E-02
				Lead	3.7E-02	mg/L	NA	NA	NA	NA	NA	8.1E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	9.6E-04	mg/kg/day	3.7E-01
				Mercury (HgCl)	5.8E-05	mg/L	NA	NA	NA	NA	NA	1.3E-08	mg/kg/day	2.1E-05	mg/kg/day	6.0E-04
				Molybdenum	1.0E-02	mg/L	NA	NA	NA	NA	NA	2.2E-06	mg/kg/day	5.0E-03	mg/kg/day	4.4E-04
				Nickel	3.3E-01	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	8.0E-04	mg/kg/day	1.8E-02
				Selenium	8.1E-04	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	5.0E-03	mg/kg/day	3.6E-05
				Silica (as SIO2)	1.6E+01	mg/L	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	NA	NA	NA
				Silver	2.2E-04	mg/L	NA	NA	NA	NA	NA	3.0E-08	mg/kg/day	2.0E-04	mg/kg/day	1.5E-04
				Thallium	2.3E-04	mg/L	NA	NA	NA	NA	NA	5.0E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.2E-03	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	1.3E-04	mg/kg/day	1.4E-02
				Zinc	6.3E+00	mg/L	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	3.0E-01	mg/kg/day	2.8E-03
			Exp. Route Total								NA					6.3E-01
		Exposure Point Total									NA					2.2E+01
	Exposure Medium Total (Swimming + Potable Use)										NA					2.3E+01
	Exposure Medium Total (Wading + Potable Use)										NA					2.2E+01
Medium Total (Swimming + Potable Use)											NA					2.3E+01
Medium Total (Wading + Potable Use)											NA					2.2E+01

TABLE 7.13.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	1.0E+00	mg/kg/day	3.1E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	4.0E-04	mg/kg/day	1.4E+00
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	7.4E-04	mg/kg/day	2.0E-01	mg/kg/day	3.7E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	1.0E-03	mg/kg/day	8.3E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	1.5E+00	mg/kg/day	5.0E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	4.0E-02	mg/kg/day	2.8E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	8.4E-03	mg/kg/day	7.0E-01	mg/kg/day	1.2E-02
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	1.4E-01	mg/kg/day	3.1E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-04	mg/kg/day	1.1E+00
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.4E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	5.0E-03	mg/kg/day	7.0E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	3.0E-01	mg/kg/day	7.8E-02
			Exp. Route Total								NA					3.9E+00
		Exposure Point Total									NA					3.9E+00
	Exposure Medium Total										NA					3.9E+00
Medium Total											NA					3.9E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					3E+01
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					3E+01

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	7.3E+01	mg/kg	8.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+01	mg/kg	3.2E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.7E-06	NA	NA	NA	NA	NA
				Barium	1.7E+02	mg/kg	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E+00	mg/kg	1.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.6E+02	mg/kg	4.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	3.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.8E+01	mg/kg	4.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	8.6E+01	mg/kg	9.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.3E+04	mg/kg	1.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+03	mg/kg	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	4.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	9.0E+02	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	2.4E-01	mg/kg	2.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	4.8E+01	mg/kg	5.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	1.1E+03	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	5.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	4.7E+03	mg/kg	5.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	8.9E+01	mg/kg	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	9.8E-01	mg/kg	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	7.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.1E+04	mg/kg	2.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.7E-06					NA

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	7.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+01	mg/kg	4.4E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.6E-07	NA	NA	NA	NA	NA
				Barium	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.6E+02	mg/kg	1.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	8.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	9.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	9.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	2.4E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	4.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	4.7E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	9.2E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	8.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	9.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.1E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.6E-07					NA
		Exposure Point Total									5.4E-06					NA
	Exposure Medium Total										5.4E-06					NA
Medium Total											5.4E-06					NA

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	4.7E-01	mg/L	3.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	4.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	2.6E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.0E-06	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	3.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	2.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	2.9E-07	mg/kg/day	5.0E-01	1/(mg/kg/day)	6.2E-07	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	2.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	4.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	4.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	4.5E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	7.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	2.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	6.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	1.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	1.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	6.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	4.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.6E-06					NA

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	4.7E-01	mg/L	3.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	4.6E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	2.8E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.2E-07	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	4.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	2.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	6.1E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	3.8E-06	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	1.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	5.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	4.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	3.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	4.7E-10	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	8.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	5.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	6.6E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	1.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	1.9E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	6.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	3.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.3E-06					NA
		Exposure Point Total									8.8E-06					NA

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	4.7E-01	mg/L	2.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	3.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	1.8E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.7E-07	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	2.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	1.5E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	8.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	4.0E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.6E-06	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	6.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	3.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	2.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	2.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	8.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	3.1E-10	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	5.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	3.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	4.4E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	8.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	7.2E-10	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	1.2E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	4.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	2.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.9E-06					NA
		Exposure Point Total									2.9E-06					NA

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	4.7E-01	mg/L	6.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	7.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	4.4E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.5E-04	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	6.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	3.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	2.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	4.8E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	7.5E-05	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	7.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	6.6E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	4.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	2.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	7.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	4.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	2.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	8.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								7.3E-04					NA

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	4.7E-01	mg/L	3.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	5.7E-04	mg/L	3.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.4E-02	mg/L	2.3E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.4E-06	NA	NA	NA	NA	NA
				Barium	5.0E-02	mg/L	3.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.8E-04	mg/L	1.9E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.6E-02	mg/L	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.7E-03	mg/L	5.0E-07	mg/kg/day	2.0E+01	1/(mg/kg/day)	3.1E-05	NA	NA	NA	NA	NA
				Cobalt	3.2E-02	mg/L	8.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.1E-03	mg/L	4.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.1E+01	mg/L	3.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.7E-02	mg/L	2.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.6E+00	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.8E-05	mg/L	3.8E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E-02	mg/L	6.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.3E-01	mg/L	4.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-04	mg/L	5.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.6E+01	mg/L	1.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.2E-04	mg/L	8.9E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	2.3E-04	mg/L	1.5E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.2E-03	mg/L	5.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	6.3E+00	mg/L	2.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.4E-05					NA
		Exposure Point Total									7.6E-04					NA
	Exposure Medium Total (Swimming + Potable Use)										7.7E-04					NA
	Exposure Medium Total (Wading + Potable Use)										7.6E-04					NA
Medium Total (Swimming + Potable Use)											7.7E-04					NA
Medium Total (Wading + Potable Use)											7.6E-04					NA

TABLE 7.14.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	5.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.3E-02	mg/kg	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	NA	NA	NA	NA	NA
				Barium	3.3E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E-02	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.7E-02	mg/kg	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.4E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.0E-02	mg/kg	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.0E-01	mg/kg	4.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	8.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.0E-02	mg/kg	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	7.6E-02	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.0E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.6E-01	mg/kg	6.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	6.9E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.0E+01	mg/kg	4.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.1E-05					NA
		Exposure Point Total									2.1E-05					NA
	Exposure Medium Total										2.1E-05					NA
Medium Total											2.1E-05					NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)											8E-04					NA
Receptor Total (Sediment + Wading + Potable Use + Fish)											8E-04					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.14.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Tar Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
							Value					Value					
					Value	Units	0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs	Units	0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)	Units	Cancer Risk (3)
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	3.7E-03	mg/L	6.6E-08	1.3E-07	4.7E-08	4.7E-08	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	6.2E-07
			Dermal	Chromium (hexavalent)	3.7E-03	mg/L	7.0E-09	1.4E-08	2.0E-08	2.0E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	3.8E-06
		Surface Water (Rivers & Creeks) Wading	Dermal	Chromium (hexavalent)	3.7E-03	mg/L	5.2E-09	1.0E-08	1.2E-08	1.2E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.6E-06
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	3.7E-03	mg/L	5.3E-06	1.1E-05	1.6E-05	1.6E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	7.5E-05
			Dermal	Chromium (hexavalent)	3.7E-03	mg/L	6.2E-08	1.2E-07	1.4E-07	1.4E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	3.1E-05

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	9.2E-02	mg/kg/day	1.0E+00	mg/kg/day	9.2E-02
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.6E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	9.2E-04	mg/kg/day	2.0E-01	mg/kg/day	4.6E-03
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	6.4E-06	mg/kg/day	2.0E-03	mg/kg/day	3.2E-03
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	1.0E-03	mg/kg/day	3.0E-02
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.5E+00	mg/kg/day	7.7E-05
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	3.0E-04	mg/kg/day	1.2E+00
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	7.1E-05	mg/kg/day	4.0E-02	mg/kg/day	1.8E-03
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	7.0E-01	mg/kg/day	1.8E-01
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	4.2E-03	mg/kg/day	2.4E-02	mg/kg/day	1.7E-01
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	4.1E-08	mg/kg/day	3.0E-04	mg/kg/day	1.4E-04
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	5.0E-03	mg/kg/day	9.8E-02
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	6.1E-03
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	5.0E-03	mg/kg/day	7.8E-03
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	5.0E-03	mg/kg/day	4.0E-02
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	3.0E-01	mg/kg/day	7.8E-03
			Exp. Route Total								NA					1.9E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	7.0E-06	mg/kg/day	3.0E-04	mg/kg/day	2.3E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	2.5E-05	mg/kg/day	6.0E-03
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					2.9E-02
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total										NA					2.0E+00
Medium Total											NA					2.0E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	5.9E-02	mg/kg/day	1.0E+00	mg/kg/day	5.9E-02
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	3.0E-04	mg/kg/day	8.2E-02
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	2.0E-01	mg/kg/day	5.3E-03
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	5.0E-04	mg/kg/day	5.2E-03
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	6.1E-05	mg/kg/day	3.0E-03	mg/kg/day	2.0E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	3.0E-04	mg/kg/day	1.0E-01
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	8.7E-05	mg/kg/day	4.0E-02	mg/kg/day	2.2E-03
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	4.7E-02	mg/kg/day	7.0E-01	mg/kg/day	6.7E-02
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	2.4E-02	mg/kg/day	7.0E-02
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	5.4E-06	mg/kg/day	5.0E-03	mg/kg/day	1.1E-03
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	3.4E-06	mg/kg/day	5.0E-03	mg/kg/day	6.7E-04
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	5.0E-03	mg/kg/day	6.9E-03
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	3.0E-01	mg/kg/day	1.7E-03
			Exp. Route Total								NA					4.3E-01
			Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	1.0E+00	mg/kg/day	1.3E-02
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	5.2E-06	mg/kg/day	3.0E-04	mg/kg/day	1.7E-02
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	1.4E-02	mg/kg/day	1.6E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	5.5E-07	mg/kg/day	2.5E-05	mg/kg/day	2.2E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	7.5E-05	mg/kg/day	3.5E-01
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	3.0E-04	mg/kg/day	8.9E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	4.0E-02	mg/kg/day	4.6E-04
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.0E-02	mg/kg/day	7.0E-01	mg/kg/day	1.4E-02
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	6.5E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	9.6E-04	mg/kg/day	3.7E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	5.0E-03	mg/kg/day	2.3E-04
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	8.0E-04	mg/kg/day	3.4E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	7.2E-07	mg/kg/day	5.0E-03	mg/kg/day	1.4E-04
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	7.3E-06	mg/kg/day	1.3E-04	mg/kg/day	5.6E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	6.5E-05	mg/kg/day	3.0E-01	mg/kg/day	2.2E-04
			Exp. Route Total								NA					8.7E-01
		Exposure Point Total									NA					1.3E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	1.0E+00	mg/kg/day	3.1E-01
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-04	mg/kg/day	4.3E-01
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	5.6E-03	mg/kg/day	2.0E-01	mg/kg/day	2.8E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	5.0E-04	mg/kg/day	2.7E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	3.0E-03	mg/kg/day	1.1E-01
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.5E-01
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.2E-02
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	2.5E-01	mg/kg/day	7.0E-01	mg/kg/day	3.5E-01
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	8.9E-03	mg/kg/day	2.4E-02	mg/kg/day	3.7E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	5.0E-03	mg/kg/day	5.7E-03
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	2.0E-02	mg/kg/day	1.7E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	5.0E-03	mg/kg/day	3.6E-03
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	5.0E-03	mg/kg/day	3.6E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	2.7E-03	mg/kg/day	3.0E-01	mg/kg/day	9.0E-03
			Exp. Route Total								NA					2.3E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	1.0E+00	mg/kg/day	1.7E-03
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	7.3E-07	mg/kg/day	3.0E-04	mg/kg/day	2.4E-03
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.4E-02	mg/kg/day	2.2E-03
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	7.7E-08	mg/kg/day	2.5E-05	mg/kg/day	3.1E-03
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	7.5E-05	mg/kg/day	4.8E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	3.7E-07	mg/kg/day	3.0E-04	mg/kg/day	1.2E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	4.0E-02	mg/kg/day	6.4E-05
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	7.0E-01	mg/kg/day	2.0E-03
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	9.1E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	5.0E-05	mg/kg/day	9.6E-04	mg/kg/day	5.2E-02
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	5.0E-03	mg/kg/day	3.2E-05
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	3.7E-07	mg/kg/day	8.0E-04	mg/kg/day	4.7E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	5.0E-03	mg/kg/day	2.0E-05
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	1.3E-04	mg/kg/day	7.8E-03
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	9.0E-06	mg/kg/day	3.0E-01	mg/kg/day	3.0E-05
			Exp. Route Total								NA					1.2E-01
		Exposure Point Total									NA					2.4E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.2E-01	mg/kg/day	1.0E+00	mg/kg/day	1.2E-01
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	5.2E-05	mg/kg/day	3.0E-04	mg/kg/day	1.7E-01
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	2.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	5.5E-06	mg/kg/day	5.0E-04	mg/kg/day	1.1E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-03	mg/kg/day	4.3E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	6.6E-05	mg/kg/day	3.0E-04	mg/kg/day	2.2E-01
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	4.0E-02	mg/kg/day	4.6E-03
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	9.9E-02	mg/kg/day	7.0E-01	mg/kg/day	1.4E-01
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	6.5E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.4E-02	mg/kg/day	1.5E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	5.0E-03	mg/kg/day	2.3E-03
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	2.0E-02	mg/kg/day	6.7E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	7.1E-06	mg/kg/day	5.0E-03	mg/kg/day	1.4E-03
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	5.0E-03	mg/kg/day	1.5E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	3.0E-01	mg/kg/day	3.6E-03
			Exp. Route Total								NA					9.1E-01
			Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	1.0E+00	mg/kg/day	2.5E-03
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	3.0E-04	mg/kg/day	3.4E-03
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	1.4E-02	mg/kg/day	3.1E-03
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	2.5E-05	mg/kg/day	4.3E-03
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	7.5E-05	mg/kg/day	6.8E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	3.0E-04	mg/kg/day	1.7E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	4.0E-02	mg/kg/day	9.1E-05
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	7.0E-01	mg/kg/day	2.8E-03
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	7.0E-05	mg/kg/day	9.6E-04	mg/kg/day	7.3E-02
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	5.0E-03	mg/kg/day	4.5E-05
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	5.3E-07	mg/kg/day	8.0E-04	mg/kg/day	6.6E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	5.0E-03	mg/kg/day	2.8E-05
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	1.3E-04	mg/kg/day	1.1E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	3.0E-01	mg/kg/day	4.2E-05
			Exp. Route Total								NA					1.7E-01
		Exposure Point Total									NA					1.1E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	1.5E+00	mg/m^3	NA	NA	NA	NA	NA	6.0E-02	mg/m^3	5.0E-03	mg/m3	1.2E+01
				Arsenic	6.0E-04	mg/m^3	NA	NA	NA	NA	NA	2.5E-05	mg/m^3	1.5E-05	mg/m3	1.7E+00
				Barium	2.6E-02	mg/m^3	NA	NA	NA	NA	NA	1.1E-03	mg/m^3	5.0E-04	mg/m3	2.2E+00
				Cadmium (water)	6.4E-05	mg/m^3	NA	NA	NA	NA	NA	2.7E-06	mg/m^3	1.0E-05	mg/m3	2.7E-01
				Chromium (hexavalent)	1.5E-03	mg/m^3	NA	NA	NA	NA	NA	6.2E-05	mg/m^3	8.0E-06	mg/m3	7.8E+00
				Cobalt	7.6E-04	mg/m^3	NA	NA	NA	NA	NA	3.2E-05	mg/m^3	6.0E-06	mg/m3	5.3E+00
				Copper	2.1E-03	mg/m^3	NA	NA	NA	NA	NA	8.9E-05	mg/m^3	NA	NA	NA
				Iron	1.2E+00	mg/m^3	NA	NA	NA	NA	NA	4.8E-02	mg/m^3	NA	NA	NA
				Lead	7.5E-04	mg/m^3	NA	NA	NA	NA	NA	3.1E-05	mg/m^3	NA	NA	NA
				Manganese (non-diet)	4.1E-02	mg/m^3	NA	NA	NA	NA	NA	1.7E-03	mg/m^3	5.0E-05	mg/m3	3.5E+01
				Molybdenum	1.3E-04	mg/m^3	NA	NA	NA	NA	NA	5.5E-06	mg/m^3	NA	NA	NA
				Nickel	1.6E-03	mg/m^3	NA	NA	NA	NA	NA	6.5E-05	mg/m^3	9.0E-05	mg/m3	7.2E-01
				Selenium	8.3E-05	mg/m^3	NA	NA	NA	NA	NA	3.5E-06	mg/m^3	2.0E-02	mg/m3	1.7E-04
				Vanadium	8.5E-04	mg/m^3	NA	NA	NA	NA	NA	3.5E-05	mg/m^3	1.0E-04	mg/m3	3.5E-01
				Zinc	1.3E-02	mg/m^3	NA	NA	NA	NA	NA	5.2E-04	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					6.5E+01
		Exposure Point Total									NA					6.5E+01
	Exposure Medium Total										NA					7.0E+01
Medium Total											NA					7.0E+01

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	1.0E+00	mg/kg/day	6.6E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.8E-01
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.6E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-03	mg/kg/day	6.9E-03
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	1.0E-03	mg/kg/day	8.5E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	1.5E+00	mg/kg/day	3.9E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	7.0E-01	mg/kg/day	2.0E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.4E-01	mg/kg/day	7.6E-02
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	1.0E-04	mg/kg/day	5.3E-01
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	5.9E-03
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	5.0E-03	mg/kg/day	2.1E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	5.0E-03	mg/kg/day	6.7E-02
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-03	mg/kg/day	4.6E-02
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	3.0E-01	mg/kg/day	1.3E-01
			Exp. Route Total								NA					2.3E+00
		Exposure Point Total									NA					2.3E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	6.0E-02	mg/kg/day	1.0E+00	mg/kg/day	6.0E-02
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-04	mg/kg/day	8.3E-01
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-02	mg/kg/day	2.0E-01	mg/kg/day	2.2E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-03	mg/kg/day	8.1E-02
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	1.0E-03	mg/kg/day	2.7E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.7E-02
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	4.0E-02	mg/kg/day	3.3E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	7.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.0E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	5.2E-01	mg/kg/day	1.4E-01	mg/kg/day	3.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	1.0E-04	mg/kg/day	5.1E-02
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.3E-03
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	5.0E-03	mg/kg/day	7.5E-01
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	5.0E-03	mg/kg/day	6.2E-02
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	3.0E-01	mg/kg/day	6.6E-01
			Exp. Route Total								NA					6.9E+00
		Exposure Point Total									NA					6.9E+00

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	1.5E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.3E-02
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.7E-03
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.0E-03	mg/kg/day	3.4E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.0E-03	mg/kg/day	2.0E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.0E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	5.0E-03
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-03	mg/kg/day	7.0E-01	mg/kg/day	4.0E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.4E-01	mg/kg/day	9.9E-03
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-06	mg/kg/day	1.0E-04	mg/kg/day	5.9E-02
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	2.0E-02	mg/kg/day	2.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	5.0E-03	mg/kg/day	5.7E-02
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	6.9E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-03	mg/kg/day	3.0E-01	mg/kg/day	3.1E-02
			Exp. Route Total								NA					2.8E-01
		Exposure Point Total									NA					2.8E-01

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	1.0E+00	mg/kg/day	4.8E-03
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.6E-01
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	2.0E-01	mg/kg/day	5.3E-04
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	2.0E-03	mg/kg/day	2.0E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E-03	mg/kg/day	4.6E-02
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	1.5E+00	mg/kg/day	2.1E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	4.0E-02	mg/kg/day	3.6E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	7.0E-01	mg/kg/day	5.4E-02
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	1.4E-01	mg/kg/day	2.4E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	1.0E-04	mg/kg/day	5.7E-01
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	2.0E-02	mg/kg/day	1.8E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					2.0E+00
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total										NA					1.1E+01

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	7.4E-01	mg/kg/day	1.0E+00	mg/kg/day	7.4E-01
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	3.0E-04	mg/kg/day	9.7E-01
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	2.0E-01	mg/kg/day	2.0E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	2.0E-03	mg/kg/day	3.9E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	1.0E-03	mg/kg/day	2.8E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	1.5E+00	mg/kg/day	3.4E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	7.1E-03	mg/kg/day	3.0E-04	mg/kg/day	2.4E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-02	mg/kg/day	4.0E-02	mg/kg/day	9.1E-01
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+01	mg/kg/day	7.0E-01	mg/kg/day	1.7E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	5.7E-01	mg/kg/day	1.4E-01	mg/kg/day	4.1E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	8.6E-05	mg/kg/day	1.0E-04	mg/kg/day	8.6E-01
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-02	mg/kg/day	1.6E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.5E-02
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	5.0E-03	mg/kg/day	9.5E-01
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+00	mg/kg/day	3.0E-01	mg/kg/day	9.1E+00
			Exp. Route Total								NA					8.8E+01
		Exposure Point Total									NA					8.8E+01

TABLE 7.15.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	3.0E-04	mg/kg/day	7.2E-04
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	2.5E-05	mg/kg/day	6.7E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.4E-03
		Exposure Point Total									NA					7.4E-03
	Exposure Medium Total										NA					8.8E+01
Medium Total											NA					1.0E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					2E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.15.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	312	234
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	8.7E+00	1.0E-03	6.0	5.2E-05	6.0	5.2E-05	3.3E+02
Arsenic	3.6E-03	1.0E-03	6.0	2.2E-08	6.0	2.2E-08	1.4E-01
Barium	1.6E-01	1.0E-03	6.0	9.4E-07	6.0	9.4E-07	5.8E+00
Cadmium (water)	3.8E-04	1.0E-03	6.0	2.3E-09	6.0	2.3E-09	1.4E-02
Chromium (hexavalent)	9.0E-03	2.0E-03	6.0	1.1E-07	6.0	1.1E-07	6.7E-01
Cobalt	4.6E-03	4.0E-04	6.0	1.1E-08	6.0	1.1E-08	6.9E-02
Copper	1.3E-02	1.0E-03	6.0	7.7E-08	6.0	7.7E-08	4.8E-01
Iron	6.9E+00	1.0E-03	6.0	4.2E-05	6.0	4.2E-05	2.6E+02
Lead	4.5E-03	1.0E-04	6.0	2.7E-09	6.0	2.7E-09	1.7E-02
Manganese (non-diet)	2.5E-01	1.0E-03	6.0	1.5E-06	6.0	1.5E-06	9.3E+00
Molybdenum	8.0E-04	1.0E-03	6.0	4.8E-09	6.0	4.8E-09	3.0E-02
Nickel	9.4E-03	2.0E-04	6.0	1.1E-08	6.0	1.1E-08	7.0E-02
Selenium	5.0E-04	1.0E-03	6.0	3.0E-09	6.0	3.0E-09	1.9E-02
Vanadium	5.1E-03	1.0E-03	6.0	3.1E-08	6.0	3.1E-08	1.9E-01
Zinc	7.6E-02	6.0E-04	6.0	2.7E-07	6.0	2.7E-07	1.7E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.15.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	8.7E+00	1.0E-03	0.71	6.2E-06	0.54	4.7E-06	4.5E+01
Arsenic	3.6E-03	1.0E-03	0.71	2.6E-09	0.54	2.0E-09	1.9E-02
Barium	1.6E-01	1.0E-03	0.71	1.1E-07	0.54	8.4E-08	8.0E-01
Cadmium (water)	3.8E-04	1.0E-03	0.71	2.7E-10	0.54	2.1E-10	2.0E-03
Chromium (hexavalent)	9.0E-03	2.0E-03	0.71	1.3E-08	0.54	9.8E-09	9.3E-02
Cobalt	4.6E-03	4.0E-04	0.71	1.3E-09	0.54	1.0E-09	9.5E-03
Copper	1.3E-02	1.0E-03	0.71	9.2E-09	0.54	7.0E-09	6.7E-02
Iron	6.9E+00	1.0E-03	0.71	4.9E-06	0.54	3.7E-06	3.6E+01
Lead	4.5E-03	1.0E-04	0.71	3.2E-10	0.54	2.5E-10	2.3E-03
Manganese (non-diet)	2.5E-01	1.0E-03	0.71	1.8E-07	0.54	1.4E-07	1.3E+00
Molybdenum	8.0E-04	1.0E-03	0.71	5.7E-10	0.54	4.3E-10	4.1E-03
Nickel	9.4E-03	2.0E-04	0.71	1.3E-09	0.54	1.0E-09	9.7E-03
Selenium	5.0E-04	1.0E-03	0.71	3.6E-10	0.54	2.7E-10	2.6E-03
Vanadium	5.1E-03	1.0E-03	0.71	3.6E-09	0.54	2.8E-09	2.6E-02
Zinc	7.6E-02	6.0E-04	0.71	3.2E-08	0.54	2.4E-08	2.3E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.15.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Sweat Lodge

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	4
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	8.7E+00	1.0E-03	1.0	8.7E-06	1.0	8.7E-06	6.3E+01
Arsenic	3.6E-03	1.0E-03	1.0	3.6E-09	1.0	3.6E-09	2.6E-02
Barium	1.6E-01	1.0E-03	1.0	1.6E-07	1.0	1.6E-07	1.1E+00
Cadmium (water)	3.8E-04	1.0E-03	1.0	3.8E-10	1.0	3.8E-10	2.8E-03
Chromium (hexavalent)	9.0E-03	2.0E-03	1.0	1.8E-08	1.0	1.8E-08	1.3E-01
Cobalt	4.6E-03	4.0E-04	1.0	1.8E-09	1.0	1.8E-09	1.3E-02
Copper	1.3E-02	1.0E-03	1.0	1.3E-08	1.0	1.3E-08	9.3E-02
Iron	6.9E+00	1.0E-03	1.0	6.9E-06	1.0	6.9E-06	5.0E+01
Lead	4.5E-03	1.0E-04	1.0	4.5E-10	1.0	4.5E-10	3.3E-03
Manganese (non-diet)	2.5E-01	1.0E-03	1.0	2.5E-07	1.0	2.5E-07	1.8E+00
Molybdenum	8.0E-04	1.0E-03	1.0	8.0E-10	1.0	8.0E-10	5.7E-03
Nickel	9.4E-03	2.0E-04	1.0	1.9E-09	1.0	1.9E-09	1.3E-02
Selenium	5.0E-04	1.0E-03	1.0	5.0E-10	1.0	5.0E-10	3.6E-03
Vanadium	5.1E-03	1.0E-03	1.0	5.1E-09	1.0	5.1E-09	3.7E-02
Zinc	7.6E-02	6.0E-04	1.0	4.5E-08	1.0	4.5E-08	3.3E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	4.3E-01	mg/kg/day	1.0E+00	mg/kg/day	4.3E-01
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-04	mg/kg/day	4.5E-01
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-03	mg/kg/day	2.0E-01	mg/kg/day	2.1E-02
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	2.0E-03	mg/kg/day	1.5E-02
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	1.0E-03	mg/kg/day	1.4E-01
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	1.5E+00	mg/kg/day	3.6E-04
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	3.0E-04	mg/kg/day	5.5E+00
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	4.0E-02	mg/kg/day	8.3E-03
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	5.9E-01	mg/kg/day	7.0E-01	mg/kg/day	8.5E-01
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.6E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	2.4E-02	mg/kg/day	8.1E-01
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	3.0E-04	mg/kg/day	6.4E-04
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	5.0E-03	mg/kg/day	4.6E-01
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	5.7E-04	mg/kg/day	2.0E-02	mg/kg/day	2.8E-02
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.4E-02
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	5.0E-03	mg/kg/day	3.6E-02
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-04	mg/kg/day	5.0E-03	mg/kg/day	1.9E-01
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	3.0E-01	mg/kg/day	3.6E-02
			Exp. Route Total								NA					9.0E+00

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	3.0E-04	mg/kg/day	3.6E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	2.5E-05	mg/kg/day	9.0E-03
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					4.5E-02
		Exposure Point Total									NA					9.1E+00
	Exposure Medium Total										NA					9.1E+00
Medium Total											NA					9.1E+00

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	1.0E+00	mg/kg/day	2.7E-01
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.7E-01
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	2.0E-01	mg/kg/day	2.4E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-04	mg/kg/day	2.4E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	3.0E-03	mg/kg/day	9.3E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.7E-01
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	4.0E-04	mg/kg/day	4.0E-02	mg/kg/day	9.9E-03
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	2.1E-01	mg/kg/day	7.0E-01	mg/kg/day	3.1E-01
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	7.7E-03	mg/kg/day	2.4E-02	mg/kg/day	3.2E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	5.0E-03	mg/kg/day	4.9E-03
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	3.1E-03
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.1E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	3.0E-01	mg/kg/day	7.8E-03
			Exp. Route Total								NA					2.0E+00

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	1.0E+00	mg/kg/day	1.4E-02
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	5.9E-06	mg/kg/day	3.0E-04	mg/kg/day	2.0E-02
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	1.4E-02	mg/kg/day	1.8E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	6.3E-07	mg/kg/day	2.5E-05	mg/kg/day	2.5E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	7.5E-05	mg/kg/day	3.9E-01
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	3.0E-06	mg/kg/day	3.0E-04	mg/kg/day	1.0E-02
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	4.0E-02	mg/kg/day	5.3E-04
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	7.0E-01	mg/kg/day	1.6E-02
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	7.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	9.6E-04	mg/kg/day	4.3E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	5.0E-03	mg/kg/day	2.6E-04
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	3.1E-06	mg/kg/day	8.0E-04	mg/kg/day	3.8E-03
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	8.2E-07	mg/kg/day	5.0E-03	mg/kg/day	1.6E-04
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	8.3E-06	mg/kg/day	1.3E-04	mg/kg/day	6.4E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	7.4E-05	mg/kg/day	3.0E-01	mg/kg/day	2.5E-04
			Exp. Route Total								NA					9.9E-01
		Exposure Point Total									NA					2.9E+00
		Surface Water (Potable Use)	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	4.5E-01	mg/kg/day	1.0E+00	mg/kg/day	4.5E-01
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	3.0E-04	mg/kg/day	6.3E-01
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	8.1E-03	mg/kg/day	2.0E-01	mg/kg/day	4.1E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	5.0E-04	mg/kg/day	4.0E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	3.0E-03	mg/kg/day	1.6E-01
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	2.4E-04	mg/kg/day	3.0E-04	mg/kg/day	8.0E-01
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	4.0E-02	mg/kg/day	1.7E-02
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	3.6E-01	mg/kg/day	7.0E-01	mg/kg/day	5.2E-01
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	2.4E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	2.4E-02	mg/kg/day	5.4E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	5.0E-03	mg/kg/day	8.3E-03
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	2.0E-02	mg/kg/day	2.4E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	5.0E-03	mg/kg/day	5.2E-03
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	5.0E-03	mg/kg/day	5.3E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	3.9E-03	mg/kg/day	3.0E-01	mg/kg/day	1.3E-02
			Exp. Route Total								NA					3.3E+00

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	1.0E+00	mg/kg/day	2.0E-03
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	8.3E-07	mg/kg/day	3.0E-04	mg/kg/day	2.8E-03
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	3.6E-05	mg/kg/day	1.4E-02	mg/kg/day	2.6E-03
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	8.8E-08	mg/kg/day	2.5E-05	mg/kg/day	3.5E-03
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	4.1E-06	mg/kg/day	7.5E-05	mg/kg/day	5.5E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	4.2E-07	mg/kg/day	3.0E-04	mg/kg/day	1.4E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	3.0E-06	mg/kg/day	4.0E-02	mg/kg/day	7.4E-05
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	7.0E-01	mg/kg/day	2.3E-03
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	9.6E-04	mg/kg/day	6.0E-02
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	5.0E-03	mg/kg/day	3.7E-05
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	4.3E-07	mg/kg/day	8.0E-04	mg/kg/day	5.4E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	5.0E-03	mg/kg/day	2.3E-05
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	1.3E-04	mg/kg/day	9.0E-03
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	3.0E-01	mg/kg/day	3.5E-05
			Exp. Route Total								NA					1.4E-01
		Exposure Point Total									NA					3.4E+00
		Surface Water (Sweat Lodge)	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	5.8E-01	mg/kg/day	1.0E+00	mg/kg/day	5.8E-01
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	2.4E-04	mg/kg/day	3.0E-04	mg/kg/day	8.1E-01
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	1.0E-02	mg/kg/day	2.0E-01	mg/kg/day	5.2E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	5.0E-04	mg/kg/day	5.1E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	6.0E-04	mg/kg/day	3.0E-03	mg/kg/day	2.0E-01
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	3.0E-04	mg/kg/day	1.0E+00
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	8.6E-04	mg/kg/day	4.0E-02	mg/kg/day	2.2E-02
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	7.0E-01	mg/kg/day	6.6E-01
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.7E-02	mg/kg/day	2.4E-02	mg/kg/day	6.9E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	5.0E-03	mg/kg/day	1.1E-02
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	6.3E-04	mg/kg/day	2.0E-02	mg/kg/day	3.1E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	5.0E-03	mg/kg/day	6.7E-03
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	5.0E-03	mg/kg/day	6.8E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	3.0E-01	mg/kg/day	1.7E-02
			Exp. Route Total								NA					4.2E+00

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	8.74E+00	mg/L	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	1.0E+00	mg/kg/day	3.7E-03
				Arsenic	3.64E-03	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	3.0E-04	mg/kg/day	5.1E-03
				Barium	1.56E-01	mg/L	NA	NA	NA	NA	NA	6.6E-05	mg/kg/day	1.4E-02	mg/kg/day	4.7E-03
				Cadmium (water)	3.85E-04	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	2.5E-05	mg/kg/day	6.5E-03
				Chromium (hexavalent)	9.03E-03	mg/L	NA	NA	NA	NA	NA	7.7E-06	mg/kg/day	7.5E-05	mg/kg/day	1.0E-01
				Cobalt	4.61E-03	mg/L	NA	NA	NA	NA	NA	7.8E-07	mg/kg/day	3.0E-04	mg/kg/day	2.6E-03
				Copper	1.29E-02	mg/L	NA	NA	NA	NA	NA	5.5E-06	mg/kg/day	4.0E-02	mg/kg/day	1.4E-04
				Iron	6.94E+00	mg/L	NA	NA	NA	NA	NA	2.9E-03	mg/kg/day	7.0E-01	mg/kg/day	4.2E-03
				Lead	4.54E-03	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.50E-01	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	9.6E-04	mg/kg/day	1.1E-01
				Molybdenum	8.00E-04	mg/L	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	5.0E-03	mg/kg/day	6.8E-05
				Nickel	9.39E-03	mg/L	NA	NA	NA	NA	NA	8.0E-07	mg/kg/day	8.0E-04	mg/kg/day	1.0E-03
				Selenium	5.00E-04	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	5.0E-03	mg/kg/day	4.2E-05
				Vanadium	5.10E-03	mg/L	NA	NA	NA	NA	NA	2.2E-06	mg/kg/day	1.3E-04	mg/kg/day	1.7E-02
				Zinc	7.56E-02	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-01	mg/kg/day	6.4E-05
			Exp. Route Total								NA					2.6E-01
		Exposure Point Total									NA					4.5E+00

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	1.5E+00	mg/m^3	NA	NA	NA	NA	NA	6.0E-02	mg/m^3	5.0E-03	mg/m3	1.2E+01
				Arsenic	6.0E-04	mg/m^3	NA	NA	NA	NA	NA	2.5E-05	mg/m^3	1.5E-05	mg/m3	1.7E+00
				Barium	2.6E-02	mg/m^3	NA	NA	NA	NA	NA	1.1E-03	mg/m^3	5.0E-04	mg/m3	2.2E+00
				Cadmium (water)	6.4E-05	mg/m^3	NA	NA	NA	NA	NA	2.7E-06	mg/m^3	1.0E-05	mg/m3	2.7E-01
				Chromium (hexavalent)	1.5E-03	mg/m^3	NA	NA	NA	NA	NA	6.2E-05	mg/m^3	8.0E-06	mg/m3	7.8E+00
				Cobalt	7.6E-04	mg/m^3	NA	NA	NA	NA	NA	3.2E-05	mg/m^3	6.0E-06	mg/m3	5.3E+00
				Copper	2.1E-03	mg/m^3	NA	NA	NA	NA	NA	8.9E-05	mg/m^3	NA	NA	NA
				Iron	1.2E+00	mg/m^3	NA	NA	NA	NA	NA	4.8E-02	mg/m^3	NA	NA	NA
				Lead	7.5E-04	mg/m^3	NA	NA	NA	NA	NA	3.1E-05	mg/m^3	NA	NA	NA
				Manganese (non-diet)	4.1E-02	mg/m^3	NA	NA	NA	NA	NA	1.7E-03	mg/m^3	5.0E-05	mg/m3	3.5E+01
				Molybdenum	1.3E-04	mg/m^3	NA	NA	NA	NA	NA	5.5E-06	mg/m^3	NA	NA	NA
				Nickel	1.6E-03	mg/m^3	NA	NA	NA	NA	NA	6.5E-05	mg/m^3	9.0E-05	mg/m3	7.2E-01
				Selenium	8.3E-05	mg/m^3	NA	NA	NA	NA	NA	3.5E-06	mg/m^3	2.0E-02	mg/m3	1.7E-04
				Vanadium	8.5E-04	mg/m^3	NA	NA	NA	NA	NA	3.5E-05	mg/m^3	1.0E-04	mg/m3	3.5E-01
				Zinc	1.3E-02	mg/m^3	NA	NA	NA	NA	NA	5.2E-04	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					6.5E+01
		Exposure Point Total									NA					6.5E+01
	Exposure Medium Total										NA					7.6E+01
Medium Total											NA					7.6E+01

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	1.0E+00	mg/kg/day	1.5E-02
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	9.5E-05	mg/kg/day	3.0E-04	mg/kg/day	3.2E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-01	mg/kg/day	3.7E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	2.0E-03	mg/kg/day	1.6E-02
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-03	mg/kg/day	2.0E-01
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.5E+00	mg/kg/day	9.1E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.7E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-02	mg/kg/day	4.2E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-02	mg/kg/day	7.0E-01	mg/kg/day	4.6E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	1.4E-01	mg/kg/day	1.8E-01
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E-04	mg/kg/day	1.2E+00
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	5.0E-03	mg/kg/day	4.9E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	7.9E-04	mg/kg/day	5.0E-03	mg/kg/day	1.6E-01
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	5.0E-03	mg/kg/day	1.1E-01
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	8.9E-02	mg/kg/day	3.0E-01	mg/kg/day	3.0E-01
			Exp. Route Total								NA					5.4E+00
		Exposure Point Total									NA					5.4E+00

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-01	mg/kg/day	1.0E+00	mg/kg/day	1.4E-01
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	3.0E-04	mg/kg/day	1.9E+00
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	2.0E-01	mg/kg/day	5.1E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	2.0E-03	mg/kg/day	1.9E-01
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	6.4E-04	mg/kg/day	1.0E-03	mg/kg/day	6.4E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	1.5E+00	mg/kg/day	3.6E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	3.0E-04	mg/kg/day	2.3E-01
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	4.0E-02	mg/kg/day	7.8E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-01	mg/kg/day	7.0E-01	mg/kg/day	2.4E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+00	mg/kg/day	1.4E-01	mg/kg/day	8.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.0E-04	mg/kg/day	1.2E-01
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.9E-02
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	5.0E-03	mg/kg/day	1.7E+00
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	5.0E-03	mg/kg/day	1.4E-01
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	3.0E-01	mg/kg/day	1.5E+00
			Exp. Route Total								NA					1.6E+01
		Exposure Point Total									NA					1.6E+01

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	1.0E+00	mg/kg/day	3.4E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.0E-03	mg/kg/day	8.0E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	1.0E-03	mg/kg/day	4.8E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	1.5E+00	mg/kg/day	2.4E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.2E-02
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	7.0E-01	mg/kg/day	9.4E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	1.4E-01	mg/kg/day	2.3E-02
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E-04	mg/kg/day	1.4E-01
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	2.0E-02	mg/kg/day	5.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	6.6E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	3.0E-01	mg/kg/day	7.2E-02
			Exp. Route Total								NA					6.5E-01
		Exposure Point Total									NA					6.5E-01

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	3.0E-04	mg/kg/day	3.0E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	2.0E-01	mg/kg/day	1.2E-03
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	9.2E-05	mg/kg/day	2.0E-03	mg/kg/day	4.6E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-03	mg/kg/day	1.1E-01
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	1.5E+00	mg/kg/day	4.9E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	4.0E-02	mg/kg/day	8.4E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.8E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.8E-04	mg/kg/day	1.4E-01	mg/kg/day	5.6E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.0E-04	mg/kg/day	1.3E+00
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	8.5E-04	mg/kg/day	2.0E-02	mg/kg/day	4.3E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	3.0E-01	mg/kg/day	3.5E-01
			Exp. Route Total								NA					4.6E+00
		Exposure Point Total									NA					4.6E+00
	Exposure Medium Total										NA					2.7E+01

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	1.7E+00	mg/kg/day	1.0E+00	mg/kg/day	1.7E+00
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-04	mg/kg/day	4.2E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	6.8E-04	mg/kg/day	3.0E-04	mg/kg/day	2.3E+00
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	9.2E-02	mg/kg/day	2.0E-01	mg/kg/day	4.6E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	2.0E-03	mg/kg/day	9.2E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	6.6E-02	mg/kg/day	1.0E-03	mg/kg/day	6.6E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	1.5E+00	mg/kg/day	7.8E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-02	mg/kg/day	3.0E-04	mg/kg/day	5.5E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-02	mg/kg/day	4.0E-02	mg/kg/day	2.1E+00
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+01	mg/kg/day	7.0E-01	mg/kg/day	3.9E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	1.3E+00	mg/kg/day	1.4E-01	mg/kg/day	9.5E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-04	mg/kg/day	2.0E+00
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-02	mg/kg/day	3.8E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	5.0E-03	mg/kg/day	2.2E+00
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	6.4E+00	mg/kg/day	3.0E-01	mg/kg/day	2.1E+01
			Exp. Route Total								NA					2.1E+02
		Exposure Point Total									NA					2.1E+02

TABLE 7.16.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	2.5E-05	mg/kg/day	9.5E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.1E-02
		Exposure Point Total									NA					1.1E-02
	Exposure Medium Total										NA					2.1E+02
Medium Total											NA					2.3E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					3E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.9E+04	mg/kg	1.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.8E+00	mg/kg	3.8E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.7E-05	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.3E+00	mg/kg	8.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.2E+00	mg/kg	4.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.4E+01	mg/kg	1.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.2E+01	mg/kg	4.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.6E+04	mg/kg	1.7E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.8E+01	mg/kg	2.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	5.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	8.4E-03	mg/kg	5.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	6.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.5E+01	mg/kg	1.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	9.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.1E+01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.8E+02	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								5.7E-05					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.8E+00	mg/kg	7.4E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.1E-05	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.2E+00	mg/kg	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.1E-05					NA
		Exposure Point Total									6.8E-05					NA
	Exposure Medium Total										6.8E-05					NA
Medium Total											6.8E-05					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	8.7E+00	mg/L	7.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	3.2E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-05	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	1.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	3.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	7.9E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	8.1E-05	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	4.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	6.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	4.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	2.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	7.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	8.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	4.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	4.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	6.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.3E-04					NA
			Dermal	Aluminum	8.7E+00	mg/L	1.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	5.3E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	8.0E-06	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	2.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	5.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	2.6E-05	mg/kg/day	2.0E+01	1/(mg/kg/day)	5.7E-04	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	2.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	6.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	2.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	7.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	7.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	6.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								5.7E-04					NA
		Exposure Point Total									7.0E-04					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	8.7E+00	mg/L	3.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	1.4E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.0E-04	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	5.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	1.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	3.4E-04	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.0E-04	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	4.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	2.6E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	9.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	2.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.0E-04					NA
			Dermal	Aluminum	8.7E+00	mg/L	1.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	7.3E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.1E-06	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	3.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	7.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	3.6E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	7.9E-05	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	3.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	1.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	9.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	3.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	1.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	1.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	9.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								8.0E-05					NA
		Exposure Point Total									4.8E-04					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	8.7E+00	mg/L	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	6.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	9.2E-05	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	2.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	6.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	1.5E-04	mg/kg/day	5.0E-01	1/(mg/kg/day)	8.8E-05	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	7.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	1.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	7.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	1.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	8.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	8.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	1.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.8E-04					NA
			Dermal	Aluminum	8.7E+00	mg/L	2.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	1.0E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.5E-06	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	5.1E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	8.4E-05	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	5.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	3.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	2.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	7.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	2.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	5.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	1.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	1.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								8.6E-05					NA
		Exposure Point Total									2.7E-04					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	1.5E+00	mg/m^3	5.9E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	6.0E-04	mg/m^3	2.4E-05	mg/m^3	4.3E-03	1/(µg/m3)	1.1E-04	NA	NA	NA	NA	NA
				Barium	2.6E-02	mg/m^3	1.0E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	6.4E-05	mg/m^3	2.6E-06	mg/m^3	1.8E-03	1/(µg/m3)	4.7E-06	NA	NA	NA	NA	NA
				Chromium (hexavalent)	1.5E-03	mg/m^3	6.1E-05	mg/m^3	8.4E-02	1/(µg/m3)	3.9E-03	NA	NA	NA	NA	NA
				Cobalt	7.6E-04	mg/m^3	3.1E-05	mg/m^3	9.0E-03	1/(µg/m3)	2.8E-04	NA	NA	NA	NA	NA
				Copper	2.1E-03	mg/m^3	8.7E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.2E+00	mg/m^3	4.7E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	7.5E-04	mg/m^3	3.0E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	4.1E-02	mg/m^3	1.7E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.3E-04	mg/m^3	5.4E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.6E-03	mg/m^3	6.3E-05	mg/m^3	2.6E-04	1/(µg/m3)	1.6E-05	NA	NA	NA	NA	NA
				Selenium	8.3E-05	mg/m^3	3.4E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.5E-04	mg/m^3	3.4E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.3E-02	mg/m^3	5.1E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.3E-03					NA
		Exposure Point Total									4.3E-03					NA
	Exposure Medium Total										5.8E-03					NA
Medium Total											5.8E-03					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	7.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.2E-02	mg/kg	4.5E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-05	NA	NA	NA	NA	NA
				Barium	2.5E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E-02	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.6E-02	mg/kg	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	6.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	4.7E-02	mg/kg	6.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.6E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.1E+01	mg/kg	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.6E-01	mg/kg	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.1E-02	mg/kg	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.2E-02	mg/kg	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-01	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.6E-01	mg/kg	3.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.9E-01	mg/kg	5.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.0E+01	mg/kg	4.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.8E-05					NA
		Exposure Point Total									6.8E-05					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	6.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.8E-01	mg/kg	2.8E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.1E-04	NA	NA	NA	NA	NA
				Barium	1.0E+02	mg/kg	4.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.4E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.4E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.8E-02	mg/kg	3.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	3.1E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+02	mg/kg	8.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.9E+00	mg/kg	9.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	5.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.2E-02	mg/kg	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.9E-01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.7E+00	mg/kg	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.3E+02	mg/kg	3.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	7.2E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+02	mg/kg	2.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.1E-04					NA
		Exposure Point Total									4.1E-04					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.5E-02	mg/kg	2.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.2E-05	NA	NA	NA	NA	NA
				Barium	4.5E+00	mg/kg	1.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E-02	mg/kg	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	5.9E-02	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.8E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	8.2E+00	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.7E-02	mg/kg	6.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.3E-01	mg/kg	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.3E-01	mg/kg	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.0E-01	mg/kg	7.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	5.7E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.7E+01	mg/kg	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.2E-05					NA
		Exposure Point Total									3.2E-05					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	5.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.1E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.9E-02	mg/kg	4.3E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.4E-05	NA	NA	NA	NA	NA
				Barium	1.1E-01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.0E-02	mg/kg	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	4.7E-02	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.2E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+01	mg/kg	4.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	5.1E-01	mg/kg	5.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	3.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.8E-02	mg/kg	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.7E-01	mg/kg	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	7.8E-01	mg/kg	8.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.6E-01	mg/kg	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+01	mg/kg	5.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-05					NA
		Exposure Point Total									6.4E-05					NA
	Exposure Medium Total										5.8E-04					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	8.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.5E-01	mg/kg	3.2E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-04	NA	NA	NA	NA	NA
				Barium	2.1E+01	mg/kg	4.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.1E-02	mg/kg	8.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+01	mg/kg	3.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.7E+00	mg/kg	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.7E+00	mg/kg	7.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.9E+01	mg/kg	4.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.1E+03	mg/kg	1.3E+01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	7.1E+01	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	6.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.5E-02	mg/kg	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.7E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.7E-01	mg/kg	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	5.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.4E+03	mg/kg	3.1E+00	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-04					NA
		Exposure Point Total									4.8E-04					NA

TABLE 7.17.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.1E-01	mg/kg	2.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.3E-07	NA	NA	NA	NA	NA
				Barium	2.0E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	2.1E+01	mg/kg	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.7E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.2E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.3E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.6E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.8E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.3E-07					NA
		Exposure Point Total									3.3E-07					NA
	Exposure Medium Total										4.9E-04					NA
Medium Total											1.1E-03					NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											7E-03					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.17.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
							Value					Value					
					Value	Units	0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs	Units	0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)	Units	Cancer Risk (3)
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	9.0E-03	mg/L	7.9E-06	1.6E-05	8.7E-06	8.7E-06	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	8.1E-05
			Dermal	Chromium (hexavalent)	9.0E-03	mg/L	8.4E-07	1.7E-06	3.7E-06	3.7E-06	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	5.7E-04
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	9.0E-03	mg/L	1.3E-05	2.7E-05	4.6E-05	4.6E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	2.0E-04
			Dermal	Chromium (hexavalent)	9.0E-03	mg/L	1.2E-07	2.4E-07	5.1E-07	5.1E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	7.9E-05
		Surface Water (Sweat Lodge)	Ingestion	Chromium (hexavalent)	9.0E-03	mg/L	n/a	3.4E-05	1.8E-05	1.8E-05	mg/kg-day	n/a	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	8.8E-05
			Dermal	Chromium (hexavalent)	9.0E-03	mg/L	n/a	4.4E-07	7.2E-07	7.2E-07	mg/kg-day	n/a	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	8.4E-05
		Water Vapor (Sweat Lodge)	Inhalation	Chromium (hexavalent)	1.5E-03	mg/m^3	n/a	3.6E-06	8.9E-06	8.9E-06	mg/m^3	n/a	2.5E-01	2.5E-01	8.4E-02	$1/(\mu g/m^3)$	3.9E-03

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
COPC = chemical of potential concern
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
$\mu g/m^3$= microgram per cubic meter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 7.18.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.9E+04	mg/kg	2.6E-02	mg/kg/day	NA	NA	NA	7.4E-02	mg/kg/day	1.0E+00	mg/kg/day	7.4E-02
				Arsenic	9.8E+00	mg/kg	8.2E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.2E-05	2.3E-05	mg/kg/day	3.0E-04	mg/kg/day	7.7E-02
				Barium	1.9E+02	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	7.4E-04	mg/kg/day	2.0E-01	mg/kg/day	3.7E-03
				Beryllium	1.3E+00	mg/kg	1.8E-06	mg/kg/day	NA	NA	NA	5.2E-06	mg/kg/day	2.0E-03	mg/kg/day	2.6E-03
				Cadmium (non-water)	6.2E+00	mg/kg	8.7E-06	mg/kg/day	NA	NA	NA	2.4E-05	mg/kg/day	1.0E-03	mg/kg/day	2.4E-02
				Chromium (trivalent)	2.4E+01	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	9.3E-05	mg/kg/day	1.5E+00	mg/kg/day	6.2E-05
				Cobalt	7.2E+01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	2.8E-04	mg/kg/day	3.0E-04	mg/kg/day	9.4E-01
				Copper	1.5E+01	mg/kg	2.0E-05	mg/kg/day	NA	NA	NA	5.7E-05	mg/kg/day	4.0E-02	mg/kg/day	1.4E-03
				Iron	2.6E+04	mg/kg	3.6E-02	mg/kg/day	NA	NA	NA	1.0E-01	mg/kg/day	7.0E-01	mg/kg/day	1.5E-01
				Lead	3.8E+01	mg/kg	5.3E-05	mg/kg/day	NA	NA	NA	1.5E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	3.4E-03	mg/kg/day	2.4E-02	mg/kg/day	1.4E-01
				Mercury (HgCl)	8.4E-03	mg/kg	1.2E-08	mg/kg/day	NA	NA	NA	3.3E-08	mg/kg/day	3.0E-04	mg/kg/day	1.1E-04
				Molybdenum	1.0E+02	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	3.9E-04	mg/kg/day	5.0E-03	mg/kg/day	7.8E-02
				Nickel	2.5E+01	mg/kg	3.5E-05	mg/kg/day	NA	NA	NA	9.7E-05	mg/kg/day	2.0E-02	mg/kg/day	4.9E-03
				Selenium	1.4E+01	mg/kg	2.0E-05	mg/kg/day	NA	NA	NA	5.5E-05	mg/kg/day	5.0E-03	mg/kg/day	1.1E-02
				Silver	8.0E+00	mg/kg	1.1E-05	mg/kg/day	NA	NA	NA	3.1E-05	mg/kg/day	5.0E-03	mg/kg/day	6.3E-03
				Vanadium	4.1E+01	mg/kg	5.7E-05	mg/kg/day	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Zinc	4.8E+02	mg/kg	6.7E-04	mg/kg/day	NA	NA	NA	1.9E-03	mg/kg/day	3.0E-01	mg/kg/day	6.2E-03
			Exp. Route Total								1.2E-05					1.6E+00

TABLE 7.18.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Arsenic	9.8E+00	mg/kg	2.0E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.1E-05	5.6E-06	mg/kg/day	3.0E-04	mg/kg/day	1.9E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	6.2E+00	mg/kg	4.3E-08	mg/kg/day	NA	NA	NA	1.2E-07	mg/kg/day	2.5E-05	mg/kg/day	4.8E-03
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								1.1E-05					2.4E-02
		Exposure Point Total									2.3E-05					1.6E+00
	Exposure Medium Total										2.3E-05					1.6E+00
Medium Total											2.3E-05					1.6E+00

TABLE 7.18.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Ingestion	Aluminum	8.7E+00	mg/L	1.7E-02	mg/kg/day	NA	NA	NA	4.7E-02	mg/kg/day	1.0E+00	mg/kg/day	4.7E-02
				Arsenic	3.6E-03	mg/L	7.0E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.1E-05	2.0E-05	mg/kg/day	3.0E-04	mg/kg/day	6.6E-02
				Barium	1.6E-01	mg/L	3.0E-04	mg/kg/day	NA	NA	NA	8.4E-04	mg/kg/day	2.0E-01	mg/kg/day	4.2E-03
				Cadmium (water)	3.8E-04	mg/L	7.4E-07	mg/kg/day	NA	NA	NA	2.1E-06	mg/kg/day	5.0E-04	mg/kg/day	4.2E-03
				Chromium (hexavalent)	9.0E-03	mg/L	1.7E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	8.7E-06	4.9E-05	mg/kg/day	3.0E-03	mg/kg/day	1.6E-02
				Cobalt	4.6E-03	mg/L	8.9E-06	mg/kg/day	NA	NA	NA	2.5E-05	mg/kg/day	3.0E-04	mg/kg/day	8.3E-02
				Copper	1.3E-02	mg/L	2.5E-05	mg/kg/day	NA	NA	NA	7.0E-05	mg/kg/day	4.0E-02	mg/kg/day	1.7E-03
				Iron	6.9E+00	mg/L	1.3E-02	mg/kg/day	NA	NA	NA	3.8E-02	mg/kg/day	7.0E-01	mg/kg/day	5.4E-02
				Lead	4.5E-03	mg/L	8.8E-06	mg/kg/day	NA	NA	NA	2.5E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	4.8E-04	mg/kg/day	NA	NA	NA	1.4E-03	mg/kg/day	2.4E-02	mg/kg/day	5.6E-02
				Molybdenum	8.0E-04	mg/L	1.5E-06	mg/kg/day	NA	NA	NA	4.3E-06	mg/kg/day	5.0E-03	mg/kg/day	8.6E-04
				Nickel	9.4E-03	mg/L	1.8E-05	mg/kg/day	NA	NA	NA	5.1E-05	mg/kg/day	2.0E-02	mg/kg/day	2.5E-03
				Selenium	5.0E-04	mg/L	9.6E-07	mg/kg/day	NA	NA	NA	2.7E-06	mg/kg/day	5.0E-03	mg/kg/day	5.4E-04
				Vanadium	5.1E-03	mg/L	9.8E-06	mg/kg/day	NA	NA	NA	2.8E-05	mg/kg/day	5.0E-03	mg/kg/day	5.5E-03
				Zinc	7.6E-02	mg/L	1.5E-04	mg/kg/day	NA	NA	NA	4.1E-04	mg/kg/day	3.0E-01	mg/kg/day	1.4E-03
			Exp. Route Total								1.9E-05					3.4E-01

TABLE 7.18.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Dermal	Aluminum	8.7E+00	mg/L	3.6E-03	mg/kg/day	NA	NA	NA	1.0E-02	mg/kg/day	1.0E+00	mg/kg/day	1.0E-02
				Arsenic	3.6E-03	mg/L	1.5E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.2E-06	4.2E-06	mg/kg/day	3.0E-04	mg/kg/day	1.4E-02
				Barium	1.6E-01	mg/L	6.4E-05	mg/kg/day	NA	NA	NA	1.8E-04	mg/kg/day	1.4E-02	mg/kg/day	1.3E-02
				Cadmium (water)	3.8E-04	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	4.4E-07	mg/kg/day	2.5E-05	mg/kg/day	1.8E-02
				Chromium (hexavalent)	9.0E-03	mg/L	7.4E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	1.5E-04	2.1E-05	mg/kg/day	7.5E-05	mg/kg/day	2.8E-01
				Cobalt	4.6E-03	mg/L	7.6E-07	mg/kg/day	NA	NA	NA	2.1E-06	mg/kg/day	3.0E-04	mg/kg/day	7.1E-03
				Copper	1.3E-02	mg/L	5.3E-06	mg/kg/day	NA	NA	NA	1.5E-05	mg/kg/day	4.0E-02	mg/kg/day	3.7E-04
				Iron	6.9E+00	mg/L	2.9E-03	mg/kg/day	NA	NA	NA	8.0E-03	mg/kg/day	7.0E-01	mg/kg/day	1.1E-02
				Lead	4.5E-03	mg/L	1.9E-07	mg/kg/day	NA	NA	NA	5.2E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	1.0E-04	mg/kg/day	NA	NA	NA	2.9E-04	mg/kg/day	9.6E-04	mg/kg/day	3.0E-01
				Molybdenum	8.0E-04	mg/L	3.3E-07	mg/kg/day	NA	NA	NA	9.2E-07	mg/kg/day	5.0E-03	mg/kg/day	1.8E-04
				Nickel	9.4E-03	mg/L	7.7E-07	mg/kg/day	NA	NA	NA	2.2E-06	mg/kg/day	8.0E-04	mg/kg/day	2.7E-03
				Selenium	5.0E-04	mg/L	2.1E-07	mg/kg/day	NA	NA	NA	5.8E-07	mg/kg/day	5.0E-03	mg/kg/day	1.2E-04
				Vanadium	5.1E-03	mg/L	2.1E-06	mg/kg/day	NA	NA	NA	5.9E-06	mg/kg/day	1.3E-04	mg/kg/day	4.5E-02
				Zinc	7.6E-02	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	5.2E-05	mg/kg/day	3.0E-01	mg/kg/day	1.7E-04
			Exp. Route Total								1.5E-04					7.0E-01
		Exposure Point Total									1.7E-04					1.0E+00
	Exposure Medium Total										1.7E-04					1.0E+00
Medium Total											1.7E-04					1.0E+00
Receptor Total (Sediment + Surface Water)											2E-04					3E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.18.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Exposure Scenario: Work Activities

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)
Aluminum	8.7E+00	1.0E-03	6.0	5.2E-05
Arsenic	3.6E-03	1.0E-03	6.0	2.2E-08
Barium	1.6E-01	1.0E-03	6.0	9.4E-07
Cadmium (water)	3.8E-04	1.0E-03	6.0	2.3E-09
Chromium (hexavalent)	9.0E-03	2.0E-03	6.0	1.1E-07
Cobalt	4.6E-03	4.0E-04	6.0	1.1E-08
Copper	1.3E-02	1.0E-03	6.0	7.7E-08
Iron	6.9E+00	1.0E-03	6.0	4.2E-05
Lead	4.5E-03	1.0E-04	6.0	2.7E-09
Manganese (non-diet)	2.5E-01	1.0E-03	6.0	1.5E-06
Molybdenum	8.0E-04	1.0E-03	6.0	4.8E-09
Nickel	9.4E-03	2.0E-04	6.0	1.1E-08
Selenium	5.0E-04	1.0E-03	6.0	3.0E-09
Vanadium	5.1E-03	1.0E-03	6.0	3.1E-08
Zinc	7.6E-02	6.0E-04	6.0	2.7E-07

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter

TABLE 7.19.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	1.0E+00	mg/kg/day	1.8E-03
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	5.6E-07	mg/kg/day	3.0E-04	mg/kg/day	1.9E-03
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	2.0E-01	mg/kg/day	9.0E-05
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	2.0E-03	mg/kg/day	6.3E-05
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	5.9E-07	mg/kg/day	1.0E-03	mg/kg/day	5.9E-04
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	1.5E+00	mg/kg/day	1.5E-06
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	3.0E-04	mg/kg/day	2.3E-02
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	4.0E-02	mg/kg/day	3.5E-05
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	7.0E-01	mg/kg/day	3.6E-03
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	8.2E-05	mg/kg/day	2.4E-02	mg/kg/day	3.4E-03
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	8.1E-10	mg/kg/day	3.0E-04	mg/kg/day	2.7E-06
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	9.6E-06	mg/kg/day	5.0E-03	mg/kg/day	1.9E-03
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	2.0E-02	mg/kg/day	1.2E-04
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	5.0E-03	mg/kg/day	2.7E-04
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	7.7E-07	mg/kg/day	5.0E-03	mg/kg/day	1.5E-04
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	5.0E-03	mg/kg/day	7.8E-04
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	3.0E-01	mg/kg/day	1.5E-04
			Exp. Route Total								NA					3.8E-02

TABLE 7.19.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	3.0E-04	mg/kg/day	4.0E-04
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-09	mg/kg/day	2.5E-05	mg/kg/day	1.0E-04
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					5.0E-04
		Exposure Point Total									NA					3.8E-02
	Exposure Medium Total										NA					3.8E-02
Medium Total											NA					3.8E-02

TABLE 7.19.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	1.0E+00	mg/kg/day	7.7E-04
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	3.2E-07	mg/kg/day	3.0E-04	mg/kg/day	1.1E-03
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-01	mg/kg/day	6.9E-05
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	3.4E-08	mg/kg/day	5.0E-04	mg/kg/day	6.8E-05
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	8.0E-07	mg/kg/day	3.0E-03	mg/kg/day	2.7E-04
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	4.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.4E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	4.0E-02	mg/kg/day	2.8E-05
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	6.1E-04	mg/kg/day	7.0E-01	mg/kg/day	8.8E-04
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	4.0E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	2.2E-05	mg/kg/day	2.4E-02	mg/kg/day	9.2E-04
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	7.1E-08	mg/kg/day	5.0E-03	mg/kg/day	1.4E-05
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	8.3E-07	mg/kg/day	2.0E-02	mg/kg/day	4.1E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	4.4E-08	mg/kg/day	5.0E-03	mg/kg/day	8.8E-06
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	4.5E-07	mg/kg/day	5.0E-03	mg/kg/day	9.0E-05
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	6.7E-06	mg/kg/day	3.0E-01	mg/kg/day	2.2E-05
			Exp. Route Total								NA					5.6E-03
			Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.0E+00	mg/kg/day	1.6E-04
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	6.9E-08	mg/kg/day	3.0E-04	mg/kg/day	2.3E-04
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	1.4E-02	mg/kg/day	2.1E-04
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	7.2E-09	mg/kg/day	2.5E-05	mg/kg/day	2.9E-04
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	7.5E-05	mg/kg/day	4.5E-03
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	3.5E-08	mg/kg/day	3.0E-04	mg/kg/day	1.2E-04
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	4.0E-02	mg/kg/day	6.1E-06
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	7.0E-01	mg/kg/day	1.9E-04
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	8.6E-09	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	4.7E-06	mg/kg/day	9.6E-04	mg/kg/day	4.9E-03
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	5.0E-03	mg/kg/day	3.0E-06
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	3.5E-08	mg/kg/day	8.0E-04	mg/kg/day	4.4E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	9.4E-09	mg/kg/day	5.0E-03	mg/kg/day	1.9E-06
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	9.6E-08	mg/kg/day	1.3E-04	mg/kg/day	7.4E-04
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	8.5E-07	mg/kg/day	3.0E-01	mg/kg/day	2.8E-06
			Exp. Route Total								NA					1.1E-02
		Exposure Point Total									NA					1.7E-02

TABLE 7.19.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	1.0E+00	mg/kg/day	1.0E-04
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	4.2E-08	mg/kg/day	3.0E-04	mg/kg/day	1.4E-04
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	1.4E-02	mg/kg/day	1.3E-04
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	4.5E-09	mg/kg/day	2.5E-05	mg/kg/day	1.8E-04
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	7.5E-05	mg/kg/day	2.8E-03
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	2.1E-08	mg/kg/day	3.0E-04	mg/kg/day	7.1E-05
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	4.0E-02	mg/kg/day	3.7E-06
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	8.0E-05	mg/kg/day	7.0E-01	mg/kg/day	1.1E-04
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	5.3E-09	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	9.6E-04	mg/kg/day	3.0E-03
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	9.3E-09	mg/kg/day	5.0E-03	mg/kg/day	1.9E-06
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	2.2E-08	mg/kg/day	8.0E-04	mg/kg/day	2.7E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	5.8E-09	mg/kg/day	5.0E-03	mg/kg/day	1.2E-06
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	5.9E-08	mg/kg/day	1.3E-04	mg/kg/day	4.5E-04
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	3.0E-01	mg/kg/day	1.7E-06
			Exp. Route Total								NA					7.0E-03
		Exposure Point Total									NA					7.0E-03
		Surface Water (Potable Use)	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	2.6E-01	mg/kg/day	1.0E+00	mg/kg/day	2.6E-01
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.6E-01
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	2.0E-01	mg/kg/day	2.3E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-04	mg/kg/day	2.3E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	3.0E-03	mg/kg/day	9.0E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.6E-01
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	4.0E-02	mg/kg/day	9.7E-03
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	2.1E-01	mg/kg/day	7.0E-01	mg/kg/day	3.0E-01
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.4E-02	mg/kg/day	3.1E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	5.0E-03	mg/kg/day	4.8E-03
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	3.0E-03
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	5.0E-03	mg/kg/day	3.1E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	3.0E-01	mg/kg/day	7.6E-03
			Exp. Route Total								NA					1.9E+00

TABLE 7.19.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	1.5E-03
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	6.1E-07	mg/kg/day	3.0E-04	mg/kg/day	2.0E-03
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	1.4E-02	mg/kg/day	1.9E-03
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	6.4E-08	mg/kg/day	2.5E-05	mg/kg/day	2.6E-03
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	3.0E-06	mg/kg/day	7.5E-05	mg/kg/day	4.0E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	3.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	2.2E-06	mg/kg/day	4.0E-02	mg/kg/day	5.4E-05
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	7.0E-01	mg/kg/day	1.7E-03
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	7.6E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	9.6E-04	mg/kg/day	4.4E-02
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	5.0E-03	mg/kg/day	2.7E-05
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	3.1E-07	mg/kg/day	8.0E-04	mg/kg/day	3.9E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	8.4E-08	mg/kg/day	5.0E-03	mg/kg/day	1.7E-05
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	8.5E-07	mg/kg/day	1.3E-04	mg/kg/day	6.6E-03
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	7.6E-06	mg/kg/day	3.0E-01	mg/kg/day	2.5E-05
			Exp. Route Total								NA					1.0E-01
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					2.0E+00
	Exposure Medium Total (Wading + Potable Use)										NA					2.0E+00
Medium Total (Swimming + Potable Use)											NA					2.0E+00
Medium Total (Wading + Potable Use)											NA					2.0E+00

TABLE 7.19.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-04	mg/kg/day	5.1E-01
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.1E-02
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	9.9E-06	mg/kg/day	2.0E-03	mg/kg/day	4.9E-03
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.0E-03	mg/kg/day	3.1E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	1.9E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	7.0E-01	mg/kg/day	4.5E-03
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	1.4E-01	mg/kg/day	1.2E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	1.0E-04	mg/kg/day	4.2E-01
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.6E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	3.0E-01	mg/kg/day	2.9E-02
			Exp. Route Total								NA					1.5E+00
		Exposure Point Total									NA					1.5E+00
	Exposure Medium Total										NA					1.5E+00
Medium Total											NA					1.5E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					4E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					4E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.19.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	8.7E+00	1.0E-03	1.0	8.7E-06	1.0	8.7E-06	1.8E+00
Arsenic	3.6E-03	1.0E-03	1.0	3.6E-09	1.0	3.6E-09	7.6E-04
Barium	1.6E-01	1.0E-03	1.0	1.6E-07	1.0	1.6E-07	3.3E-02
Cadmium (water)	3.8E-04	1.0E-03	1.0	3.8E-10	1.0	3.8E-10	8.0E-05
Chromium (hexavalent)	9.0E-03	2.0E-03	1.0	1.8E-08	1.0	1.8E-08	3.8E-03
Cobalt	4.6E-03	4.0E-04	1.0	1.8E-09	1.0	1.8E-09	3.9E-04
Copper	1.3E-02	1.0E-03	1.0	1.3E-08	1.0	1.3E-08	2.7E-03
Iron	6.9E+00	1.0E-03	1.0	6.9E-06	1.0	6.9E-06	1.5E+00
Lead	4.5E-03	1.0E-04	1.0	4.5E-10	1.0	4.5E-10	9.5E-05
Manganese (non-diet)	2.5E-01	1.0E-03	1.0	2.5E-07	1.0	2.5E-07	5.2E-02
Molybdenum	8.0E-04	1.0E-03	1.0	8.0E-10	1.0	8.0E-10	1.7E-04
Nickel	9.4E-03	2.0E-04	1.0	1.9E-09	1.0	1.9E-09	3.9E-04
Selenium	5.0E-04	1.0E-03	1.0	5.0E-10	1.0	5.0E-10	1.0E-04
Vanadium	5.1E-03	1.0E-03	1.0	5.1E-09	1.0	5.1E-09	1.1E-03
Zinc	7.6E-02	6.0E-04	1.0	4.5E-08	1.0	4.5E-08	9.5E-03

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.19.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Wading

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	6,032	2,373
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	8.7E+00	1.0E-03	2.0	1.7E-05	2.0	1.7E-05	1.2E+00
Arsenic	3.6E-03	1.0E-03	2.0	7.3E-09	2.0	7.3E-09	5.0E-04
Barium	1.6E-01	1.0E-03	2.0	3.1E-07	2.0	3.1E-07	2.1E-02
Cadmium (water)	3.8E-04	1.0E-03	2.0	7.7E-10	2.0	7.7E-10	5.3E-05
Chromium (hexavalent)	9.0E-03	2.0E-03	2.0	3.6E-08	2.0	3.6E-08	2.5E-03
Cobalt	4.6E-03	4.0E-04	2.0	3.7E-09	2.0	3.7E-09	2.5E-04
Copper	1.3E-02	1.0E-03	2.0	2.6E-08	2.0	2.6E-08	1.8E-03
Iron	6.9E+00	1.0E-03	2.0	1.4E-05	2.0	1.4E-05	9.6E-01
Lead	4.5E-03	1.0E-04	2.0	9.1E-10	2.0	9.1E-10	6.2E-05
Manganese (non-diet)	2.5E-01	1.0E-03	2.0	5.0E-07	2.0	5.0E-07	3.4E-02
Molybdenum	8.0E-04	1.0E-03	2.0	1.6E-09	2.0	1.6E-09	1.1E-04
Nickel	9.4E-03	2.0E-04	2.0	3.8E-09	2.0	3.8E-09	2.6E-04
Selenium	5.0E-04	1.0E-03	2.0	1.0E-09	2.0	1.0E-09	6.9E-05
Vanadium	5.1E-03	1.0E-03	2.0	1.0E-08	2.0	1.0E-08	7.0E-04
Zinc	7.6E-02	6.0E-04	2.0	9.1E-08	2.0	9.1E-08	6.2E-03

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.19.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	350	350
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	8.7E+00	1.0E-03	0.71	6.2E-06	0.54	4.7E-06	1.5E+01
Arsenic	3.6E-03	1.0E-03	0.71	2.6E-09	0.54	2.0E-09	6.2E-03
Barium	1.6E-01	1.0E-03	0.71	1.1E-07	0.54	8.4E-08	2.7E-01
Cadmium (water)	3.8E-04	1.0E-03	0.71	2.7E-10	0.54	2.1E-10	6.5E-04
Chromium (hexavalent)	9.0E-03	2.0E-03	0.71	1.3E-08	0.54	9.8E-09	3.1E-02
Cobalt	4.6E-03	4.0E-04	0.71	1.3E-09	0.54	1.0E-09	3.1E-03
Copper	1.3E-02	1.0E-03	0.71	9.2E-09	0.54	7.0E-09	2.2E-02
Iron	6.9E+00	1.0E-03	0.71	4.9E-06	0.54	3.7E-06	1.2E+01
Lead	4.5E-03	1.0E-04	0.71	3.2E-10	0.54	2.5E-10	7.7E-04
Manganese (non-diet)	2.5E-01	1.0E-03	0.71	1.8E-07	0.54	1.4E-07	4.3E-01
Molybdenum	8.0E-04	1.0E-03	0.71	5.7E-10	0.54	4.3E-10	1.4E-03
Nickel	9.4E-03	2.0E-04	0.71	1.3E-09	0.54	1.0E-09	3.2E-03
Selenium	5.0E-04	1.0E-03	0.71	3.6E-10	0.54	2.7E-10	8.5E-04
Vanadium	5.1E-03	1.0E-03	0.71	3.6E-09	0.54	2.8E-09	8.7E-03
Zinc	7.6E-02	6.0E-04	0.71	3.2E-08	0.54	2.4E-08	7.7E-02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.20.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	1.9E-02	mg/kg/day	1.0E+00	mg/kg/day	1.9E-02
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	6.0E-06	mg/kg/day	3.0E-04	mg/kg/day	2.0E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	2.0E-01	mg/kg/day	9.6E-04
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	2.0E-03	mg/kg/day	6.8E-04
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	6.3E-06	mg/kg/day	1.0E-03	mg/kg/day	6.3E-03
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	1.5E+00	mg/kg/day	1.6E-05
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	7.4E-05	mg/kg/day	3.0E-04	mg/kg/day	2.5E-01
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	4.0E-02	mg/kg/day	3.7E-04
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	2.7E-02	mg/kg/day	7.0E-01	mg/kg/day	3.8E-02
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	8.8E-04	mg/kg/day	2.4E-02	mg/kg/day	3.6E-02
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	8.6E-09	mg/kg/day	3.0E-04	mg/kg/day	2.9E-05
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	5.0E-03	mg/kg/day	2.0E-02
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	2.0E-02	mg/kg/day	1.3E-03
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	5.0E-03	mg/kg/day	2.9E-03
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	8.2E-06	mg/kg/day	5.0E-03	mg/kg/day	1.6E-03
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	5.0E-03	mg/kg/day	8.3E-03
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	3.0E-01	mg/kg/day	1.6E-03
			Exp. Route Total								NA					4.1E-01

TABLE 7.20.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Arsenic	9.8E+00	mg/kg	NA	NA	NA	NA	NA	7.1E-07	mg/kg/day	3.0E-04	mg/kg/day	2.4E-03
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	6.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	2.5E-05	mg/kg/day	6.0E-04
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					3.0E-03
		Exposure Point Total									NA					4.1E-01
	Exposure Medium Total										NA					4.1E-01
Medium Total											NA					4.1E-01

TABLE 7.20.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	5.4E-03	mg/kg/day	1.0E+00	mg/kg/day	5.4E-03
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	2.2E-06	mg/kg/day	3.0E-04	mg/kg/day	7.4E-03
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	9.6E-05	mg/kg/day	2.0E-01	mg/kg/day	4.8E-04
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	5.0E-04	mg/kg/day	4.7E-04
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	5.5E-06	mg/kg/day	3.0E-03	mg/kg/day	1.8E-03
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	3.0E-04	mg/kg/day	9.4E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	7.9E-06	mg/kg/day	4.0E-02	mg/kg/day	2.0E-04
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	4.3E-03	mg/kg/day	7.0E-01	mg/kg/day	6.1E-03
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	2.4E-02	mg/kg/day	6.4E-03
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	4.9E-07	mg/kg/day	5.0E-03	mg/kg/day	9.8E-05
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	5.8E-06	mg/kg/day	2.0E-02	mg/kg/day	2.9E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	3.1E-07	mg/kg/day	5.0E-03	mg/kg/day	6.1E-05
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	3.1E-06	mg/kg/day	5.0E-03	mg/kg/day	6.3E-04
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	3.0E-01	mg/kg/day	1.5E-04
			Exp. Route Total								NA					3.9E-02
			Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.0E+00	mg/kg/day	2.8E-04
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	3.0E-04	mg/kg/day	3.9E-04
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	1.4E-02	mg/kg/day	3.6E-04
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	1.3E-08	mg/kg/day	2.5E-05	mg/kg/day	5.0E-04
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	5.9E-07	mg/kg/day	7.5E-05	mg/kg/day	7.8E-03
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	6.0E-08	mg/kg/day	3.0E-04	mg/kg/day	2.0E-04
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	4.2E-07	mg/kg/day	4.0E-02	mg/kg/day	1.0E-05
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	7.0E-01	mg/kg/day	3.2E-04
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	8.1E-06	mg/kg/day	9.6E-04	mg/kg/day	8.5E-03
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.6E-08	mg/kg/day	5.0E-03	mg/kg/day	5.2E-06
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	6.1E-08	mg/kg/day	8.0E-04	mg/kg/day	7.6E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.6E-08	mg/kg/day	5.0E-03	mg/kg/day	3.3E-06
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	1.3E-04	mg/kg/day	1.3E-03
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	3.0E-01	mg/kg/day	4.9E-06
			Exp. Route Total								NA					2.0E-02
		Exposure Point Total									NA					5.9E-02

TABLE 7.20.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	2.1E-04	mg/kg/day	1.0E+00	mg/kg/day	2.1E-04
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	8.8E-08	mg/kg/day	3.0E-04	mg/kg/day	2.9E-04
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	3.8E-06	mg/kg/day	1.4E-02	mg/kg/day	2.7E-04
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	9.3E-09	mg/kg/day	2.5E-05	mg/kg/day	3.7E-04
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	4.4E-07	mg/kg/day	7.5E-05	mg/kg/day	5.8E-03
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	4.5E-08	mg/kg/day	3.0E-04	mg/kg/day	1.5E-04
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	3.1E-07	mg/kg/day	4.0E-02	mg/kg/day	7.8E-06
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	7.0E-01	mg/kg/day	2.4E-04
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.1E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	6.1E-06	mg/kg/day	9.6E-04	mg/kg/day	6.3E-03
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.9E-08	mg/kg/day	5.0E-03	mg/kg/day	3.9E-06
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	4.6E-08	mg/kg/day	8.0E-04	mg/kg/day	5.7E-05
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.2E-08	mg/kg/day	5.0E-03	mg/kg/day	2.4E-06
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	1.3E-04	mg/kg/day	9.5E-04
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	3.0E-01	mg/kg/day	3.7E-06
			Exp. Route Total								NA					1.5E-02
		Exposure Point Total									NA					1.5E-02
		Surface Water (Potable Use)	Ingestion	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	4.4E-01	mg/kg/day	1.0E+00	mg/kg/day	4.4E-01
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	3.0E-04	mg/kg/day	6.1E-01
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	7.8E-03	mg/kg/day	2.0E-01	mg/kg/day	3.9E-02
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	5.0E-04	mg/kg/day	3.8E-02
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	3.0E-03	mg/kg/day	1.5E-01
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	3.0E-04	mg/kg/day	7.7E-01
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	6.4E-04	mg/kg/day	4.0E-02	mg/kg/day	1.6E-02
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	3.5E-01	mg/kg/day	7.0E-01	mg/kg/day	4.9E-01
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	2.4E-02	mg/kg/day	5.2E-01
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	4.0E-05	mg/kg/day	5.0E-03	mg/kg/day	8.0E-03
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	2.0E-02	mg/kg/day	2.3E-02
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	5.0E-03	mg/kg/day	5.0E-03
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	5.0E-03	mg/kg/day	5.1E-02
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	3.8E-03	mg/kg/day	3.0E-01	mg/kg/day	1.3E-02
			Exp. Route Total								NA					3.2E+00

TABLE 7.20.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	8.7E+00	mg/L	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	1.0E+00	mg/kg/day	1.9E-03
				Arsenic	3.6E-03	mg/L	NA	NA	NA	NA	NA	8.0E-07	mg/kg/day	3.0E-04	mg/kg/day	2.7E-03
				Barium	1.6E-01	mg/L	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	1.4E-02	mg/kg/day	2.4E-03
				Cadmium (water)	3.8E-04	mg/L	NA	NA	NA	NA	NA	8.5E-08	mg/kg/day	2.5E-05	mg/kg/day	3.4E-03
				Chromium (hexavalent)	9.0E-03	mg/L	NA	NA	NA	NA	NA	4.0E-06	mg/kg/day	7.5E-05	mg/kg/day	5.3E-02
				Cobalt	4.6E-03	mg/L	NA	NA	NA	NA	NA	4.1E-07	mg/kg/day	3.0E-04	mg/kg/day	1.4E-03
				Copper	1.3E-02	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	4.0E-02	mg/kg/day	7.1E-05
				Iron	6.9E+00	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	7.0E-01	mg/kg/day	2.2E-03
				Lead	4.5E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	NA	NA	NA	NA	NA	5.5E-05	mg/kg/day	9.6E-04	mg/kg/day	5.7E-02
				Molybdenum	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	5.0E-03	mg/kg/day	3.5E-05
				Nickel	9.4E-03	mg/L	NA	NA	NA	NA	NA	4.1E-07	mg/kg/day	8.0E-04	mg/kg/day	5.2E-04
				Selenium	5.0E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	5.0E-03	mg/kg/day	2.2E-05
				Vanadium	5.1E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	1.3E-04	mg/kg/day	8.6E-03
				Zinc	7.6E-02	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	3.0E-01	mg/kg/day	3.3E-05
			Exp. Route Total								NA					1.3E-01
		Exposure Point Total									NA					3.3E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					3.4E+00
	Exposure Medium Total (Wading + Potable Use)										NA					3.3E+00
Medium Total (Swimming + Potable Use)											NA					3.4E+00
Medium Total (Wading + Potable Use)											NA					3.3E+00

TABLE 7.20.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	1.0E+00	mg/kg/day	3.1E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	4.0E-04	mg/kg/day	1.4E+00
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	7.4E-04	mg/kg/day	2.0E-01	mg/kg/day	3.7E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	1.0E-03	mg/kg/day	8.3E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	1.5E+00	mg/kg/day	5.0E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	4.0E-02	mg/kg/day	2.8E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	8.4E-03	mg/kg/day	7.0E-01	mg/kg/day	1.2E-02
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	1.4E-01	mg/kg/day	3.1E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-04	mg/kg/day	1.1E+00
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.4E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	5.0E-03	mg/kg/day	7.0E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	3.0E-01	mg/kg/day	7.8E-02
			Exp. Route Total								NA					3.9E+00
		Exposure Point Total									NA					3.9E+00
	Exposure Medium Total										NA					3.9E+00
Medium Total											NA					3.9E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					8E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					8E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.21.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.9E+04	mg/kg	2.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.8E+00	mg/kg	6.8E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.0E-06	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.3E+00	mg/kg	1.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.2E+00	mg/kg	7.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.4E+01	mg/kg	2.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.2E+01	mg/kg	8.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.6E+04	mg/kg	3.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.8E+01	mg/kg	4.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	9.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	8.4E-03	mg/kg	9.7E-10	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.5E+01	mg/kg	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	1.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	9.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.1E+01	mg/kg	4.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.8E+02	mg/kg	5.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.0E-06					NA

TABLE 7.21.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.8E+00	mg/kg	9.5E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.4E-07	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.2E+00	mg/kg	2.0E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	2.6E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.8E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	8.6E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	8.4E-03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.8E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.4E-07					NA
		Exposure Point Total									1.2E-06					NA
	Exposure Medium Total										1.2E-06					NA
Medium Total											1.2E-06					NA

TABLE 7.21.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	8.7E+00	mg/L	6.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	2.8E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.2E-07	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	3.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	7.0E-07	mg/kg/day	5.0E-01	1/(mg/kg/day)	1.5E-06	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	3.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	1.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	5.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	3.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	6.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	7.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	3.9E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	4.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	5.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.9E-06					NA
			Dermal	Aluminum	8.7E+00	mg/L	7.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	3.0E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.5E-08	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	3.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	1.5E-07	mg/kg/day	2.0E+01	1/(mg/kg/day)	9.3E-06	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	1.5E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	5.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	3.7E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	2.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	6.5E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	1.5E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	4.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	4.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	3.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								9.3E-06					NA
		Exposure Point Total									1.1E-05					NA

TABLE 7.21.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	8.7E+00	mg/L	4.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	2.0E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.9E-08	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	8.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	2.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	9.7E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	6.4E-06	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	9.9E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	6.9E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	3.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	2.4E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	4.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	1.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	2.7E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	2.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	2.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-06					NA
		Exposure Point Total									6.4E-06					NA
		Surface Water (Potable Use)	Ingestion	Aluminum	8.7E+00	mg/L	1.1E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	4.7E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	7.0E-05	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	2.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	4.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	1.2E-04	mg/kg/day	5.0E-01	1/(mg/kg/day)	1.8E-04	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	8.9E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	5.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	3.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	6.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	6.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	9.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.5E-04					NA

TABLE 7.21.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	8.7E+00	mg/L	5.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.6E-03	mg/L	2.4E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.6E-07	NA	NA	NA	NA	NA
				Barium	1.6E-01	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.8E-04	mg/L	2.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	9.0E-03	mg/L	1.2E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	7.4E-05	NA	NA	NA	NA	NA
				Cobalt	4.6E-03	mg/L	1.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.3E-02	mg/L	8.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.9E+00	mg/L	4.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.5E-03	mg/L	3.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.5E-01	mg/L	1.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	8.0E-04	mg/L	5.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.4E-03	mg/L	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	5.0E-04	mg/L	3.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	5.1E-03	mg/L	3.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-02	mg/L	3.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								7.4E-05					NA
		Exposure Point Total									3.2E-04					NA
	Exposure Medium Total (Swimming + Potable Use)										3.4E-04					NA
	Exposure Medium Total (Wading + Potable Use)										3.3E-04					NA
Medium Total (Swimming + Potable Use)											3.4E-04					NA
Medium Total (Wading + Potable Use)											3.3E-04					NA

TABLE 7.21.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	5.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.3E-02	mg/kg	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	NA	NA	NA	NA	NA
				Barium	3.3E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E-02	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.7E-02	mg/kg	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.4E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.0E-02	mg/kg	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.0E-01	mg/kg	4.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	8.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.0E-02	mg/kg	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	7.6E-02	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.0E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.6E-01	mg/kg	6.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	6.9E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.0E+01	mg/kg	4.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.1E-05					NA
		Exposure Point Total									2.1E-05					NA
	Exposure Medium Total										2.1E-05					NA
Medium Total											2.1E-05					NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)											4E-04					NA
Receptor Total (Sediment + Wading + Potable Use + Fish)											4E-04					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.21.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Neosho River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
							Value					Value					
					Value	Units	0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs	Units	0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)	Units	Cancer Risk (3)
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	9.0E-03	mg/L	1.6E-07	3.2E-07	1.1E-07	1.1E-07	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	1.5E-06
			Dermal	Chromium (hexavalent)	9.0E-03	mg/L	1.7E-08	3.4E-08	4.9E-08	4.9E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	9.3E-06
		Surface Water (Rivers & Creeks) Wading	Dermal	Chromium (hexavalent)	9.0E-03	mg/L	1.3E-08	2.5E-08	3.0E-08	3.0E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	6.4E-06
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	9.0E-03	mg/L	1.3E-05	2.6E-05	3.9E-05	3.9E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	1.8E-04
			Dermal	Chromium (hexavalent)	9.0E-03	mg/L	1.5E-07	3.0E-07	3.3E-07	3.3E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	7.4E-05

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	5.9E-02	mg/kg/day	1.0E+00	mg/kg/day	5.9E-02
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	4.0E-04	mg/kg/day	3.7E-02
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	7.4E-05	mg/kg/day	3.0E-04	mg/kg/day	2.5E-01
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	9.1E-04	mg/kg/day	2.0E-01	mg/kg/day	4.5E-03
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	5.6E-06	mg/kg/day	2.0E-03	mg/kg/day	2.8E-03
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	1.0E-03	mg/kg/day	7.3E-01
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	1.9E-04
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.6E-01
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	4.0E-02	mg/kg/day	1.8E-03
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	1.6E-01	mg/kg/day	7.0E-01	mg/kg/day	2.3E-01
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	2.4E-02	mg/kg/day	4.6E-01
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	3.0E-04	mg/kg/day	7.6E-03
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	5.0E-03	mg/kg/day	9.8E-02
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-02	mg/kg/day	8.2E-03
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	2.9E-02	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	5.0E-03	mg/kg/day	7.8E-03
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	6.2E-06	mg/kg/day	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	1.2E-01	mg/kg/day	3.0E-01	mg/kg/day	3.9E-01
			Exp. Route Total								NA					2.7E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	3.0E-04	mg/kg/day	6.0E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	2.5E-05	mg/kg/day	1.4E-01
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					2.0E-01
		Exposure Point Total									NA					2.9E+00
	Exposure Medium Total										NA					2.9E+00
Medium Total											NA					2.9E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	9.5E-03	mg/kg/day	1.0E+00	mg/kg/day	9.5E-03
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	3.0E-04	mg/kg/day	1.9E-01
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	2.0E-01	mg/kg/day	2.5E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-04	mg/kg/day	2.4E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	2.2E-05	mg/kg/day	3.0E-03	mg/kg/day	7.4E-03
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	3.0E-04	mg/kg/day	1.8E-01
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	4.3E-05	mg/kg/day	4.0E-02	mg/kg/day	1.1E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.7E-02
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	7.2E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.4E-02	mg/kg/day	6.4E-02
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	9.8E-05	mg/kg/day	2.0E-02	mg/kg/day	4.9E-03
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	5.0E-03	mg/kg/day	2.7E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	5.0E-03	mg/kg/day	4.6E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	5.0E-05	mg/kg/day	5.0E-03	mg/kg/day	9.9E-03
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	4.0E-03	mg/kg/day	3.0E-01	mg/kg/day	1.3E-02
			Exp. Route Total								NA					5.2E-01

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	1.0E+00	mg/kg/day	2.0E-03
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	3.0E-04	mg/kg/day	4.0E-02
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.4E-02	mg/kg/day	7.7E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	2.5E-05	mg/kg/day	1.0E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	9.4E-06	mg/kg/day	7.5E-05	mg/kg/day	1.3E-01
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	4.5E-06	mg/kg/day	3.0E-04	mg/kg/day	1.5E-02
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	9.2E-06	mg/kg/day	4.0E-02	mg/kg/day	2.3E-04
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	7.0E-01	mg/kg/day	3.7E-03
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	9.6E-04	mg/kg/day	3.4E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	4.2E-06	mg/kg/day	8.0E-04	mg/kg/day	5.2E-03
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	5.0E-03	mg/kg/day	5.8E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	2.9E-07	mg/kg/day	2.0E-04	mg/kg/day	1.5E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	5.9E-07	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	1.3E-04	mg/kg/day	8.2E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	3.0E-01	mg/kg/day	1.7E-03
			Exp. Route Total								NA					7.3E-01
		Exposure Point Total									NA					1.3E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	5.0E-02	mg/kg/day	1.0E+00	mg/kg/day	5.0E-02
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	3.0E-04	mg/kg/day	1.0E+00
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	2.7E-03	mg/kg/day	2.0E-01	mg/kg/day	1.3E-02
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	6.4E-05	mg/kg/day	5.0E-04	mg/kg/day	1.3E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	3.0E-03	mg/kg/day	3.9E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	3.0E-04	mg/kg/day	9.3E-01
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	4.0E-02	mg/kg/day	5.7E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	6.4E-02	mg/kg/day	7.0E-01	mg/kg/day	9.1E-02
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	8.1E-03	mg/kg/day	2.4E-02	mg/kg/day	3.4E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	5.2E-04	mg/kg/day	2.0E-02	mg/kg/day	2.6E-02
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	7.1E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	5.5E-01	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.4E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	2.6E-04	mg/kg/day	5.0E-03	mg/kg/day	5.3E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	2.1E-02	mg/kg/day	3.0E-01	mg/kg/day	7.0E-02
			Exp. Route Total								NA					2.8E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.0E+00	mg/kg/day	2.8E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	3.0E-04	mg/kg/day	5.6E-03
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	1.4E-02	mg/kg/day	1.1E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	3.6E-07	mg/kg/day	2.5E-05	mg/kg/day	1.4E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	7.5E-05	mg/kg/day	1.7E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	6.3E-07	mg/kg/day	3.0E-04	mg/kg/day	2.1E-03
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	4.0E-02	mg/kg/day	3.2E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	7.0E-01	mg/kg/day	5.1E-04
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	9.6E-04	mg/kg/day	4.7E-02
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	5.8E-07	mg/kg/day	8.0E-04	mg/kg/day	7.2E-04
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	4.0E-07	mg/kg/day	5.0E-03	mg/kg/day	8.0E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	4.1E-08	mg/kg/day	2.0E-04	mg/kg/day	2.0E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	8.1E-08	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	1.3E-04	mg/kg/day	1.1E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	7.0E-05	mg/kg/day	3.0E-01	mg/kg/day	2.3E-04
			Exp. Route Total								NA					1.0E-01
		Exposure Point Total									NA					2.9E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	1.0E+00	mg/kg/day	2.0E-02
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	3.0E-04	mg/kg/day	4.0E-01
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	2.0E-01	mg/kg/day	5.3E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	5.0E-04	mg/kg/day	5.1E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	4.7E-05	mg/kg/day	3.0E-03	mg/kg/day	1.6E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	3.0E-04	mg/kg/day	3.7E-01
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	9.1E-05	mg/kg/day	4.0E-02	mg/kg/day	2.3E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.6E-02	mg/kg/day	7.0E-01	mg/kg/day	3.7E-02
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.4E-02	mg/kg/day	1.4E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	2.1E-04	mg/kg/day	2.0E-02	mg/kg/day	1.0E-02
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	5.0E-03	mg/kg/day	5.7E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.2E-01	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	4.9E-06	mg/kg/day	5.0E-03	mg/kg/day	9.7E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	5.8E-06	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-03	mg/kg/day	2.1E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	8.4E-03	mg/kg/day	3.0E-01	mg/kg/day	2.8E-02
			Exp. Route Total								NA					1.1E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	1.0E+00	mg/kg/day	3.9E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	3.0E-04	mg/kg/day	7.9E-03
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	1.4E-02	mg/kg/day	1.5E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.0E-07	mg/kg/day	2.5E-05	mg/kg/day	2.0E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	7.5E-05	mg/kg/day	2.5E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	8.8E-07	mg/kg/day	3.0E-04	mg/kg/day	2.9E-03
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	4.0E-02	mg/kg/day	4.5E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	7.0E-01	mg/kg/day	7.2E-04
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	6.4E-05	mg/kg/day	9.6E-04	mg/kg/day	6.6E-02
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	8.1E-07	mg/kg/day	8.0E-04	mg/kg/day	1.0E-03
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	5.6E-07	mg/kg/day	5.0E-03	mg/kg/day	1.1E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	4.3E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	5.7E-08	mg/kg/day	2.0E-04	mg/kg/day	2.9E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	2.1E-06	mg/kg/day	1.3E-04	mg/kg/day	1.6E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	9.9E-05	mg/kg/day	3.0E-01	mg/kg/day	3.3E-04
			Exp. Route Total								NA					1.4E-01
		Exposure Point Total									NA					1.2E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	2.3E-01	mg/m^3	NA	NA	NA	NA	NA	9.7E-03	mg/m^3	5.0E-03	mg/m3	1.9E+00
				Arsenic	1.4E-03	mg/m^3	NA	NA	NA	NA	NA	5.8E-05	mg/m^3	1.5E-05	mg/m3	3.9E+00
				Barium	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	5.2E-04	mg/m^3	5.0E-04	mg/m3	1.0E+00
				Cadmium (water)	3.0E-04	mg/m^3	NA	NA	NA	NA	NA	1.2E-05	mg/m^3	1.0E-05	mg/m3	1.2E+00
				Chromium (hexavalent)	5.4E-04	mg/m^3	NA	NA	NA	NA	NA	2.3E-05	mg/m^3	8.0E-06	mg/m3	2.8E+00
				Cobalt	1.3E-03	mg/m^3	NA	NA	NA	NA	NA	5.4E-05	mg/m^3	6.0E-06	mg/m3	9.0E+00
				Copper	1.1E-03	mg/m^3	NA	NA	NA	NA	NA	4.4E-05	mg/m^3	NA	NA	NA
				Iron	3.0E-01	mg/m^3	NA	NA	NA	NA	NA	1.2E-02	mg/m^3	NA	NA	NA
				Lead	1.8E-03	mg/m^3	NA	NA	NA	NA	NA	7.3E-05	mg/m^3	NA	NA	NA
				Manganese (non-diet)	3.8E-02	mg/m^3	NA	NA	NA	NA	NA	1.6E-03	mg/m^3	5.0E-05	mg/m3	3.1E+01
				Nickel	2.4E-03	mg/m^3	NA	NA	NA	NA	NA	1.0E-04	mg/m^3	9.0E-05	mg/m3	1.1E+00
				Selenium	3.3E-04	mg/m^3	NA	NA	NA	NA	NA	1.4E-05	mg/m^3	2.0E-02	mg/m3	6.9E-04
				Silica (as SIO2)	2.6E+00	mg/m^3	NA	NA	NA	NA	NA	1.1E-01	mg/m^3	NA	NA	NA
				Silver	5.6E-05	mg/m^3	NA	NA	NA	NA	NA	2.4E-06	mg/m^3	NA	NA	NA
				Thallium	6.8E-05	mg/m^3	NA	NA	NA	NA	NA	2.8E-06	mg/m^3	NA	NA	NA
				Vanadium	1.2E-03	mg/m^3	NA	NA	NA	NA	NA	5.1E-05	mg/m^3	1.0E-04	mg/m3	5.1E-01
				Zinc	9.7E-02	mg/m^3	NA	NA	NA	NA	NA	4.1E-03	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					5.3E+01
		Exposure Point Total									NA					5.3E+01
	Exposure Medium Total										NA					5.8E+01
Medium Total											NA					5.8E+01

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	1.0E+00	mg/kg/day	6.6E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.8E-01
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.6E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-03	mg/kg/day	6.9E-03
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	1.0E-03	mg/kg/day	8.5E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	1.5E+00	mg/kg/day	3.9E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	7.0E-01	mg/kg/day	2.0E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.4E-01	mg/kg/day	7.6E-02
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	1.0E-04	mg/kg/day	5.3E-01
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	5.9E-03
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	5.0E-03	mg/kg/day	2.1E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	5.0E-03	mg/kg/day	6.7E-02
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-03	mg/kg/day	4.6E-02
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	3.0E-01	mg/kg/day	1.3E-01
			Exp. Route Total								NA					2.3E+00
		Exposure Point Total									NA					2.3E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	6.0E-02	mg/kg/day	1.0E+00	mg/kg/day	6.0E-02
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-04	mg/kg/day	8.3E-01
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-02	mg/kg/day	2.0E-01	mg/kg/day	2.2E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-03	mg/kg/day	8.1E-02
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	1.0E-03	mg/kg/day	2.7E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.7E-02
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	4.0E-02	mg/kg/day	3.3E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	7.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.0E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	5.2E-01	mg/kg/day	1.4E-01	mg/kg/day	3.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	1.0E-04	mg/kg/day	5.1E-02
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.3E-03
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	5.0E-03	mg/kg/day	7.5E-01
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	5.0E-03	mg/kg/day	6.2E-02
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	3.0E-01	mg/kg/day	6.6E-01
			Exp. Route Total								NA					6.9E+00
		Exposure Point Total									NA					6.9E+00

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	1.5E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.3E-02
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.7E-03
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.0E-03	mg/kg/day	3.4E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.0E-03	mg/kg/day	2.0E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.0E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	5.0E-03
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-03	mg/kg/day	7.0E-01	mg/kg/day	4.0E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.4E-01	mg/kg/day	9.9E-03
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-06	mg/kg/day	1.0E-04	mg/kg/day	5.9E-02
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	2.0E-02	mg/kg/day	2.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	5.0E-03	mg/kg/day	5.7E-02
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	6.9E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-03	mg/kg/day	3.0E-01	mg/kg/day	3.1E-02
			Exp. Route Total								NA					2.8E-01
		Exposure Point Total									NA					2.8E-01

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	1.0E+00	mg/kg/day	4.8E-03
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.6E-01
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	2.0E-01	mg/kg/day	5.3E-04
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	2.0E-03	mg/kg/day	2.0E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E-03	mg/kg/day	4.6E-02
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	1.5E+00	mg/kg/day	2.1E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	4.0E-02	mg/kg/day	3.6E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	7.0E-01	mg/kg/day	5.4E-02
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	1.4E-01	mg/kg/day	2.4E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	1.0E-04	mg/kg/day	5.7E-01
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	2.0E-02	mg/kg/day	1.8E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					2.0E+00
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total										NA					1.1E+01

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	7.4E-01	mg/kg/day	1.0E+00	mg/kg/day	7.4E-01
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	3.0E-04	mg/kg/day	9.7E-01
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	2.0E-01	mg/kg/day	2.0E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	2.0E-03	mg/kg/day	3.9E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	1.0E-03	mg/kg/day	2.8E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	1.5E+00	mg/kg/day	3.4E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	7.1E-03	mg/kg/day	3.0E-04	mg/kg/day	2.4E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-02	mg/kg/day	4.0E-02	mg/kg/day	9.1E-01
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+01	mg/kg/day	7.0E-01	mg/kg/day	1.7E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	5.7E-01	mg/kg/day	1.4E-01	mg/kg/day	4.1E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	8.6E-05	mg/kg/day	1.0E-04	mg/kg/day	8.6E-01
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-02	mg/kg/day	1.6E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.5E-02
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	5.0E-03	mg/kg/day	9.5E-01
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+00	mg/kg/day	3.0E-01	mg/kg/day	9.1E+00
			Exp. Route Total								NA					8.8E+01
		Exposure Point Total									NA					8.8E+01

TABLE 7.22.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	3.0E-04	mg/kg/day	7.2E-04
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	2.5E-05	mg/kg/day	6.7E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.4E-03
		Exposure Point Total									NA					7.4E-03
	Exposure Medium Total										NA					8.8E+01
Medium Total											NA					1.0E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					2E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.22.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	312	234
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.4E+00	1.0E-03	6.0	8.4E-06	6.0	8.4E-06	5.2E+01
Arsenic	8.4E-03	1.0E-03	6.0	5.1E-08	6.0	5.1E-08	3.1E-01
Barium	7.5E-02	1.0E-03	6.0	4.5E-07	6.0	4.5E-07	2.8E+00
Cadmium (water)	1.8E-03	1.0E-03	6.0	1.1E-08	6.0	1.1E-08	6.7E-02
Chromium (hexavalent)	3.3E-03	2.0E-03	6.0	3.9E-08	6.0	3.9E-08	2.4E-01
Cobalt	7.9E-03	4.0E-04	6.0	1.9E-08	6.0	1.9E-08	1.2E-01
Copper	6.4E-03	1.0E-03	6.0	3.8E-08	6.0	3.8E-08	2.4E-01
Iron	1.8E+00	1.0E-03	6.0	1.1E-05	6.0	1.1E-05	6.7E+01
Lead	1.1E-02	1.0E-04	6.0	6.4E-09	6.0	6.4E-09	4.0E-02
Manganese (non-diet)	2.3E-01	1.0E-03	6.0	1.4E-06	6.0	1.4E-06	8.4E+00
Nickel	1.5E-02	2.0E-04	6.0	1.7E-08	6.0	1.7E-08	1.1E-01
Selenium	2.0E-03	1.0E-03	6.0	1.2E-08	6.0	1.2E-08	7.4E-02
Silica (as SIO2)	1.5E+01	1.0E-03	6.0	9.3E-05	6.0	9.3E-05	5.8E+02
Silver	3.4E-04	6.0E-04	6.0	1.2E-09	6.0	1.2E-09	7.6E-03
Thallium	4.1E-04	1.0E-03	6.0	2.5E-09	6.0	2.5E-09	1.5E-02
Vanadium	7.4E-03	1.0E-03	6.0	4.4E-08	6.0	4.4E-08	2.7E-01
Zinc	5.9E-01	6.0E-04	6.0	2.1E-06	6.0	2.1E-06	1.3E+01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.22.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.4E+00	1.0E-03	0.71	1.0E-06	0.54	7.6E-07	7.2E+00
Arsenic	8.4E-03	1.0E-03	0.71	6.0E-09	0.54	4.6E-09	4.3E-02
Barium	7.5E-02	1.0E-03	0.71	5.3E-08	0.54	4.0E-08	3.9E-01
Cadmium (water)	1.8E-03	1.0E-03	0.71	1.3E-09	0.54	9.7E-10	9.2E-03
Chromium (hexavalent)	3.3E-03	2.0E-03	0.71	4.7E-09	0.54	3.5E-09	3.4E-02
Cobalt	7.9E-03	4.0E-04	0.71	2.2E-09	0.54	1.7E-09	1.6E-02
Copper	6.4E-03	1.0E-03	0.71	4.5E-09	0.54	3.4E-09	3.3E-02
Iron	1.8E+00	1.0E-03	0.71	1.3E-06	0.54	9.7E-07	9.2E+00
Lead	1.1E-02	1.0E-04	0.71	7.5E-10	0.54	5.7E-10	5.5E-03
Manganese (non-diet)	2.3E-01	1.0E-03	0.71	1.6E-07	0.54	1.2E-07	1.2E+00
Nickel	1.5E-02	2.0E-04	0.71	2.1E-09	0.54	1.6E-09	1.5E-02
Selenium	2.0E-03	1.0E-03	0.71	1.4E-09	0.54	1.1E-09	1.0E-02
Silica (as SIO2)	1.5E+01	1.0E-03	0.71	1.1E-05	0.54	8.4E-06	8.0E+01
Silver	3.4E-04	6.0E-04	0.71	1.4E-10	0.54	1.1E-10	1.1E-03
Thallium	4.1E-04	1.0E-03	0.71	2.9E-10	0.54	2.2E-10	2.1E-03
Vanadium	7.4E-03	1.0E-03	0.71	5.2E-09	0.54	4.0E-09	3.8E-02
Zinc	5.9E-01	6.0E-04	0.71	2.5E-07	0.54	1.9E-07	1.8E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.22.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Sweat Lodge

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	4
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.4E+00	1.0E-03	1.0	1.4E-06	1.0	1.4E-06	1.0E+01
Arsenic	8.4E-03	1.0E-03	1.0	8.4E-09	1.0	8.4E-09	6.1E-02
Barium	7.5E-02	1.0E-03	1.0	7.5E-08	1.0	7.5E-08	5.4E-01
Cadmium (water)	1.8E-03	1.0E-03	1.0	1.8E-09	1.0	1.8E-09	1.3E-02
Chromium (hexavalent)	3.3E-03	2.0E-03	1.0	6.6E-09	1.0	6.6E-09	4.7E-02
Cobalt	7.9E-03	4.0E-04	1.0	3.1E-09	1.0	3.1E-09	2.3E-02
Copper	6.4E-03	1.0E-03	1.0	6.4E-09	1.0	6.4E-09	4.6E-02
Iron	1.8E+00	1.0E-03	1.0	1.8E-06	1.0	1.8E-06	1.3E+01
Lead	1.1E-02	1.0E-04	1.0	1.1E-09	1.0	1.1E-09	7.6E-03
Manganese (non-diet)	2.3E-01	1.0E-03	1.0	2.3E-07	1.0	2.3E-07	1.6E+00
Nickel	1.5E-02	2.0E-04	1.0	2.9E-09	1.0	2.9E-09	2.1E-02
Selenium	2.0E-03	1.0E-03	1.0	2.0E-09	1.0	2.0E-09	1.4E-02
Silica (as SIO2)	1.5E+01	1.0E-03	1.0	1.5E-05	1.0	1.5E-05	1.1E+02
Silver	3.4E-04	6.0E-04	1.0	2.0E-10	1.0	2.0E-10	1.5E-03
Thallium	4.1E-04	1.0E-03	1.0	4.1E-10	1.0	4.1E-10	2.9E-03
Vanadium	7.4E-03	1.0E-03	1.0	7.4E-09	1.0	7.4E-09	5.3E-02
Zinc	5.9E-01	6.0E-04	1.0	3.5E-07	1.0	3.5E-07	2.5E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	1.0E+00	mg/kg/day	2.7E-01
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	4.0E-04	mg/kg/day	1.7E-01
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	3.0E-04	mg/kg/day	1.1E+00
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	4.2E-03	mg/kg/day	2.0E-01	mg/kg/day	2.1E-02
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	1.0E-03	mg/kg/day	3.4E+00
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	1.5E+00	mg/kg/day	8.6E-04
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	3.0E-04	mg/kg/day	1.7E+00
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	4.0E-02	mg/kg/day	8.5E-03
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	7.6E-01	mg/kg/day	7.0E-01	mg/kg/day	1.1E+00
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	5.1E-02	mg/kg/day	2.4E-02	mg/kg/day	2.1E+00
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	3.0E-04	mg/kg/day	3.6E-02
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	5.0E-03	mg/kg/day	4.6E-01
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	2.0E-02	mg/kg/day	3.8E-02
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.4E-02
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	1.4E-01	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	5.0E-03	mg/kg/day	3.6E-02
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	5.4E-01	mg/kg/day	3.0E-01	mg/kg/day	1.8E+00
			Exp. Route Total								NA					1.3E+01

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.1E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	5.4E-06	mg/kg/day	2.5E-05	mg/kg/day	2.2E-01
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					3.1E-01
		Exposure Point Total									NA					1.3E+01
	Exposure Medium Total										NA					1.3E+01
Medium Total											NA					1.3E+01

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	4.3E-02	mg/kg/day	1.0E+00	mg/kg/day	4.3E-02
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	2.6E-04	mg/kg/day	3.0E-04	mg/kg/day	8.6E-01
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.5E-05	mg/kg/day	5.0E-04	mg/kg/day	1.1E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	3.0E-03	mg/kg/day	3.4E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	2.4E-04	mg/kg/day	3.0E-04	mg/kg/day	8.1E-01
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	4.9E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.5E-02	mg/kg/day	7.0E-01	mg/kg/day	7.9E-02
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	7.0E-03	mg/kg/day	2.4E-02	mg/kg/day	2.9E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	2.0E-02	mg/kg/day	2.2E-02
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	6.2E-05	mg/kg/day	5.0E-03	mg/kg/day	1.2E-02
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	4.8E-01	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	5.0E-03	mg/kg/day	2.1E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-03	mg/kg/day	4.5E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	1.8E-02	mg/kg/day	3.0E-01	mg/kg/day	6.0E-02
			Exp. Route Total								NA					2.4E+00

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	1.0E+00	mg/kg/day	2.3E-03
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	3.0E-04	mg/kg/day	4.6E-02
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.4E-02	mg/kg/day	8.7E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	2.5E-05	mg/kg/day	1.2E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	7.5E-05	mg/kg/day	1.4E-01
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	3.0E-04	mg/kg/day	1.7E-02
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	4.0E-02	mg/kg/day	2.6E-04
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.9E-03	mg/kg/day	7.0E-01	mg/kg/day	4.2E-03
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	3.7E-04	mg/kg/day	9.6E-04	mg/kg/day	3.9E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	4.7E-06	mg/kg/day	8.0E-04	mg/kg/day	5.9E-03
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	3.3E-06	mg/kg/day	5.0E-03	mg/kg/day	6.5E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	3.3E-07	mg/kg/day	2.0E-04	mg/kg/day	1.7E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	6.7E-07	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.3E-04	mg/kg/day	9.3E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	5.7E-04	mg/kg/day	3.0E-01	mg/kg/day	1.9E-03
			Exp. Route Total								NA					8.3E-01
		Exposure Point Total									NA					3.2E+00

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	7.3E-02	mg/kg/day	1.0E+00	mg/kg/day	7.3E-02
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	4.4E-04	mg/kg/day	3.0E-04	mg/kg/day	1.5E+00
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	3.9E-03	mg/kg/day	2.0E-01	mg/kg/day	1.9E-02
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	9.3E-05	mg/kg/day	5.0E-04	mg/kg/day	1.9E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	3.0E-03	mg/kg/day	5.7E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	3.0E-04	mg/kg/day	1.4E+00
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	4.0E-02	mg/kg/day	8.3E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	9.3E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	5.5E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	2.4E-02	mg/kg/day	4.9E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	2.0E-02	mg/kg/day	3.8E-02
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	5.0E-03	mg/kg/day	2.1E-02
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	8.0E-01	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	5.0E-03	mg/kg/day	3.5E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	5.0E-03	mg/kg/day	7.7E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	3.1E-02	mg/kg/day	3.0E-01	mg/kg/day	1.0E-01
			Exp. Route Total								NA					4.0E+00

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	1.0E+00	mg/kg/day	3.2E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.9E-06	mg/kg/day	3.0E-04	mg/kg/day	6.4E-03
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	1.4E-02	mg/kg/day	1.2E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	4.1E-07	mg/kg/day	2.5E-05	mg/kg/day	1.6E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	7.5E-05	mg/kg/day	2.0E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	7.2E-07	mg/kg/day	3.0E-04	mg/kg/day	2.4E-03
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	4.0E-02	mg/kg/day	3.6E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	7.0E-01	mg/kg/day	5.9E-04
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	5.2E-05	mg/kg/day	9.6E-04	mg/kg/day	5.4E-02
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	6.6E-07	mg/kg/day	8.0E-04	mg/kg/day	8.3E-04
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	4.6E-07	mg/kg/day	5.0E-03	mg/kg/day	9.2E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.5E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	4.7E-08	mg/kg/day	2.0E-04	mg/kg/day	2.3E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	9.4E-08	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	1.3E-04	mg/kg/day	1.3E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	8.1E-05	mg/kg/day	3.0E-01	mg/kg/day	2.7E-04
			Exp. Route Total								NA					1.2E-01
		Exposure Point Total									NA					4.1E+00

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	9.4E-02	mg/kg/day	1.0E+00	mg/kg/day	9.4E-02
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	5.6E-04	mg/kg/day	3.0E-04	mg/kg/day	1.9E+00
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	2.0E-01	mg/kg/day	2.5E-02
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	5.0E-04	mg/kg/day	2.4E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	3.0E-03	mg/kg/day	7.3E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	5.2E-04	mg/kg/day	3.0E-04	mg/kg/day	1.7E+00
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.2E-01	mg/kg/day	7.0E-01	mg/kg/day	1.7E-01
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	2.4E-02	mg/kg/day	6.3E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	9.7E-04	mg/kg/day	2.0E-02	mg/kg/day	4.8E-02
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.7E-02
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	5.0E-03	mg/kg/day	4.5E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	5.0E-03	mg/kg/day	9.8E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	3.9E-02	mg/kg/day	3.0E-01	mg/kg/day	1.3E-01
			Exp. Route Total								NA					5.2E+00

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	6.0E-04	mg/kg/day	1.0E+00	mg/kg/day	6.0E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	1.4E-02	mg/kg/day	2.3E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	7.6E-07	mg/kg/day	2.5E-05	mg/kg/day	3.0E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	7.5E-05	mg/kg/day	3.7E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	3.0E-04	mg/kg/day	4.4E-03
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	4.0E-02	mg/kg/day	6.8E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	7.6E-04	mg/kg/day	7.0E-01	mg/kg/day	1.1E-03
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	4.5E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	9.6E-05	mg/kg/day	9.6E-04	mg/kg/day	1.0E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	8.0E-04	mg/kg/day	1.5E-03
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	8.5E-07	mg/kg/day	5.0E-03	mg/kg/day	1.7E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	8.7E-08	mg/kg/day	2.0E-04	mg/kg/day	4.3E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	3.1E-06	mg/kg/day	1.3E-04	mg/kg/day	2.4E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	3.0E-01	mg/kg/day	5.0E-04
			Exp. Route Total								NA					2.1E-01
		Exposure Point Total									NA					5.4E+00

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	2.3E-01	mg/m^3	NA	NA	NA	NA	NA	9.7E-03	mg/m^3	5.0E-03	mg/m3	1.9E+00
				Arsenic	1.4E-03	mg/m^3	NA	NA	NA	NA	NA	5.8E-05	mg/m^3	1.5E-05	mg/m3	3.9E+00
				Barium	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	5.2E-04	mg/m^3	5.0E-04	mg/m3	1.0E+00
				Cadmium (water)	3.0E-04	mg/m^3	NA	NA	NA	NA	NA	1.2E-05	mg/m^3	1.0E-05	mg/m3	1.2E+00
				Chromium (hexavalent)	5.4E-04	mg/m^3	NA	NA	NA	NA	NA	2.3E-05	mg/m^3	8.0E-06	mg/m3	2.8E+00
				Cobalt	1.3E-03	mg/m^3	NA	NA	NA	NA	NA	5.4E-05	mg/m^3	6.0E-06	mg/m3	9.0E+00
				Copper	1.1E-03	mg/m^3	NA	NA	NA	NA	NA	4.4E-05	mg/m^3	NA	NA	NA
				Iron	3.0E-01	mg/m^3	NA	NA	NA	NA	NA	1.2E-02	mg/m^3	NA	NA	NA
				Lead	1.8E-03	mg/m^3	NA	NA	NA	NA	NA	7.3E-05	mg/m^3	NA	NA	NA
				Manganese (non-diet)	3.8E-02	mg/m^3	NA	NA	NA	NA	NA	1.6E-03	mg/m^3	5.0E-05	mg/m3	3.1E+01
				Nickel	2.4E-03	mg/m^3	NA	NA	NA	NA	NA	1.0E-04	mg/m^3	9.0E-05	mg/m3	1.1E+00
				Selenium	3.3E-04	mg/m^3	NA	NA	NA	NA	NA	1.4E-05	mg/m^3	2.0E-02	mg/m3	6.9E-04
				Silica (as SIO2)	2.6E+00	mg/m^3	NA	NA	NA	NA	NA	1.1E-01	mg/m^3	NA	NA	NA
				Silver	5.6E-05	mg/m^3	NA	NA	NA	NA	NA	2.4E-06	mg/m^3	NA	NA	NA
				Thallium	6.8E-05	mg/m^3	NA	NA	NA	NA	NA	2.8E-06	mg/m^3	NA	NA	NA
				Vanadium	1.2E-03	mg/m^3	NA	NA	NA	NA	NA	5.1E-05	mg/m^3	1.0E-04	mg/m3	5.1E-01
				Zinc	9.7E-02	mg/m^3	NA	NA	NA	NA	NA	4.1E-03	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					5.3E+01
		Exposure Point Total									NA					5.3E+01
	Exposure Medium Total (Swimming)										NA					6.6E+01
Medium Total (Swimming)											NA					6.6E+01

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	1.0E+00	mg/kg/day	1.5E-02
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	9.5E-05	mg/kg/day	3.0E-04	mg/kg/day	3.2E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-01	mg/kg/day	3.7E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	2.0E-03	mg/kg/day	1.6E-02
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-03	mg/kg/day	2.0E-01
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.5E+00	mg/kg/day	9.1E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.7E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-02	mg/kg/day	4.2E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-02	mg/kg/day	7.0E-01	mg/kg/day	4.6E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	1.4E-01	mg/kg/day	1.8E-01
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E-04	mg/kg/day	1.2E+00
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	5.0E-03	mg/kg/day	4.9E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	7.9E-04	mg/kg/day	5.0E-03	mg/kg/day	1.6E-01
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	5.0E-03	mg/kg/day	1.1E-01
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	8.9E-02	mg/kg/day	3.0E-01	mg/kg/day	3.0E-01
			Exp. Route Total								NA					5.4E+00
		Exposure Point Total									NA					5.4E+00

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-01	mg/kg/day	1.0E+00	mg/kg/day	1.4E-01
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	3.0E-04	mg/kg/day	1.9E+00
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	2.0E-01	mg/kg/day	5.1E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	2.0E-03	mg/kg/day	1.9E-01
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	6.4E-04	mg/kg/day	1.0E-03	mg/kg/day	6.4E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	1.5E+00	mg/kg/day	3.6E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	3.0E-04	mg/kg/day	2.3E-01
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	4.0E-02	mg/kg/day	7.8E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-01	mg/kg/day	7.0E-01	mg/kg/day	2.4E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+00	mg/kg/day	1.4E-01	mg/kg/day	8.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.0E-04	mg/kg/day	1.2E-01
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.9E-02
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	5.0E-03	mg/kg/day	1.7E+00
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	5.0E-03	mg/kg/day	1.4E-01
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	3.0E-01	mg/kg/day	1.5E+00
			Exp. Route Total								NA					1.6E+01
		Exposure Point Total									NA					1.6E+01

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	1.0E+00	mg/kg/day	3.4E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.0E-03	mg/kg/day	8.0E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	1.0E-03	mg/kg/day	4.8E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	1.5E+00	mg/kg/day	2.4E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.2E-02
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	7.0E-01	mg/kg/day	9.4E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	1.4E-01	mg/kg/day	2.3E-02
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E-04	mg/kg/day	1.4E-01
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	2.0E-02	mg/kg/day	5.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	6.6E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	3.0E-01	mg/kg/day	7.2E-02
			Exp. Route Total								NA					6.5E-01
		Exposure Point Total									NA					6.5E-01

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	3.0E-04	mg/kg/day	3.0E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	2.0E-01	mg/kg/day	1.2E-03
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	9.2E-05	mg/kg/day	2.0E-03	mg/kg/day	4.6E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-03	mg/kg/day	1.1E-01
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	1.5E+00	mg/kg/day	4.9E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	4.0E-02	mg/kg/day	8.4E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.8E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.8E-04	mg/kg/day	1.4E-01	mg/kg/day	5.6E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.0E-04	mg/kg/day	1.3E+00
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	8.5E-04	mg/kg/day	2.0E-02	mg/kg/day	4.3E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	3.0E-01	mg/kg/day	3.5E-01
			Exp. Route Total								NA					4.6E+00
		Exposure Point Total									NA					4.6E+00
	Exposure Medium Total										NA					2.7E+01

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	1.7E+00	mg/kg/day	1.0E+00	mg/kg/day	1.7E+00
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-04	mg/kg/day	4.2E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	6.8E-04	mg/kg/day	3.0E-04	mg/kg/day	2.3E+00
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	9.2E-02	mg/kg/day	2.0E-01	mg/kg/day	4.6E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	2.0E-03	mg/kg/day	9.2E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	6.6E-02	mg/kg/day	1.0E-03	mg/kg/day	6.6E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	1.5E+00	mg/kg/day	7.8E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-02	mg/kg/day	3.0E-04	mg/kg/day	5.5E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-02	mg/kg/day	4.0E-02	mg/kg/day	2.1E+00
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+01	mg/kg/day	7.0E-01	mg/kg/day	3.9E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	1.3E+00	mg/kg/day	1.4E-01	mg/kg/day	9.5E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-04	mg/kg/day	2.0E+00
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-02	mg/kg/day	3.8E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	5.0E-03	mg/kg/day	2.2E+00
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	6.4E+00	mg/kg/day	3.0E-01	mg/kg/day	2.1E+01
			Exp. Route Total								NA					2.1E+02
		Exposure Point Total									NA					2.1E+02

TABLE 7.23.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	2.5E-05	mg/kg/day	9.5E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.1E-02
		Exposure Point Total									NA					1.1E-02
	Exposure Medium Total										NA					2.1E+02
Medium Total											NA					2.3E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					3E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.2E+04	mg/kg	7.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.0E+00	mg/kg	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	2.5E+01	mg/kg	9.7E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.5E-04	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E+00	mg/kg	7.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+02	mg/kg	9.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.7E+01	mg/kg	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.2E+01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	9.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.3E+04	mg/kg	2.1E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	2.7E+02	mg/kg	1.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	1.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.7E-01	mg/kg	3.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	6.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.4E+01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	9.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.0E+03	mg/kg	3.9E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.3E+00	mg/kg	8.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	2.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.4E+04	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.5E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	2.5E+01	mg/kg	1.9E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.8E-05	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+02	mg/kg	3.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.8E-05					NA
		Exposure Point Total									1.7E-04					NA
	Exposure Medium Total										1.7E-04					NA
Medium Total											1.7E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.4E+00	mg/L	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	7.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.1E-04	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	6.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	2.9E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.9E-05	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	6.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	5.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	9.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	2.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	1.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	3.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	3.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	6.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	5.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.4E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.4E+00	mg/L	2.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	1.2E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.8E-05	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	9.6E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.1E-04	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	4.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	9.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	2.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	1.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	3.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	4.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	2.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	3.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	6.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	1.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.2E-04					NA
		Exposure Point Total									3.6E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.4E+00	mg/L	5.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	3.1E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.7E-04	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	2.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	6.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	1.2E-04	mg/kg/day	5.0E-01	1/(mg/kg/day)	7.2E-05	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	2.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	2.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	6.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	3.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	8.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	5.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	7.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	5.7E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	2.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	2.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								5.4E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	2.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	1.7E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.6E-06	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	3.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	1.3E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.9E-05	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	6.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	2.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	4.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	5.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	4.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	4.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	8.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	1.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	7.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.1E-05					NA
		Exposure Point Total									5.7E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	1.4E+00	mg/L	2.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	1.4E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-04	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	1.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	5.5E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	3.2E-05	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	3.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	3.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	2.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	3.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	2.6E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	6.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	9.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.5E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	3.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	2.4E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.6E-06	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	2.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	5.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	1.8E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	3.1E-05	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	8.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	1.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	5.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	3.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	8.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	5.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	4.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	5.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	2.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	9.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.4E-05					NA
		Exposure Point Total									2.8E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	2.3E-01	mg/m^3	9.4E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.4E-03	mg/m^3	5.7E-05	mg/m^3	4.3E-03	1/(µg/m3)	2.4E-04	NA	NA	NA	NA	NA
				Barium	1.2E-02	mg/m^3	5.0E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.0E-04	mg/m^3	1.2E-05	mg/m^3	1.8E-03	1/(µg/m3)	2.2E-05	NA	NA	NA	NA	NA
				Chromium (hexavalent)	5.4E-04	mg/m^3	2.2E-05	mg/m^3	8.4E-02	1/(µg/m3)	1.4E-03	NA	NA	NA	NA	NA
				Cobalt	1.3E-03	mg/m^3	5.3E-05	mg/m^3	9.0E-03	1/(µg/m3)	4.7E-04	NA	NA	NA	NA	NA
				Copper	1.1E-03	mg/m^3	4.3E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.0E-01	mg/m^3	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.8E-03	mg/m^3	7.1E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	3.8E-02	mg/m^3	1.5E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	2.4E-03	mg/m^3	9.7E-05	mg/m^3	2.6E-04	1/(µg/m3)	2.5E-05	NA	NA	NA	NA	NA
				Selenium	3.3E-04	mg/m^3	1.3E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	2.6E+00	mg/m^3	1.0E-01	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	5.6E-05	mg/m^3	2.3E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	6.8E-05	mg/m^3	2.7E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.2E-03	mg/m^3	5.0E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	9.7E-02	mg/m^3	3.9E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.2E-03					NA
		Exposure Point Total									2.2E-03					NA
	Exposure Medium Total (Swimming)										3.4E-03					NA
Medium Total (Swimming)											3.4E-03					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	7.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.2E-02	mg/kg	4.5E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-05	NA	NA	NA	NA	NA
				Barium	2.5E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E-02	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.6E-02	mg/kg	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	6.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	4.7E-02	mg/kg	6.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.6E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.1E+01	mg/kg	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.6E-01	mg/kg	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.1E-02	mg/kg	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.2E-02	mg/kg	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-01	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.6E-01	mg/kg	3.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.9E-01	mg/kg	5.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.0E+01	mg/kg	4.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.8E-05					NA
		Exposure Point Total									6.8E-05					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	6.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.8E-01	mg/kg	2.8E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.1E-04	NA	NA	NA	NA	NA
				Barium	1.0E+02	mg/kg	4.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.4E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.4E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.8E-02	mg/kg	3.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	3.1E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+02	mg/kg	8.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.9E+00	mg/kg	9.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	5.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.2E-02	mg/kg	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.9E-01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.7E+00	mg/kg	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.3E+02	mg/kg	3.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	7.2E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+02	mg/kg	2.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.1E-04					NA
		Exposure Point Total									4.1E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.5E-02	mg/kg	2.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.2E-05	NA	NA	NA	NA	NA
				Barium	4.5E+00	mg/kg	1.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E-02	mg/kg	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	5.9E-02	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.8E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	8.2E+00	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.7E-02	mg/kg	6.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.3E-01	mg/kg	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.3E-01	mg/kg	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.0E-01	mg/kg	7.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	5.7E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.7E+01	mg/kg	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.2E-05					NA
		Exposure Point Total									3.2E-05					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	5.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.1E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.9E-02	mg/kg	4.3E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.4E-05	NA	NA	NA	NA	NA
				Barium	1.1E-01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.0E-02	mg/kg	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	4.7E-02	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.2E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+01	mg/kg	4.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	5.1E-01	mg/kg	5.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	3.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.8E-02	mg/kg	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.7E-01	mg/kg	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	7.8E-01	mg/kg	8.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.6E-01	mg/kg	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+01	mg/kg	5.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-05					NA
		Exposure Point Total									6.4E-05					NA
	Exposure Medium Total										5.8E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	8.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.5E-01	mg/kg	3.2E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-04	NA	NA	NA	NA	NA
				Barium	2.1E+01	mg/kg	4.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.1E-02	mg/kg	8.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+01	mg/kg	3.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.7E+00	mg/kg	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.7E+00	mg/kg	7.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.9E+01	mg/kg	4.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.1E+03	mg/kg	1.3E+01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	7.1E+01	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	6.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.5E-02	mg/kg	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.7E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.7E-01	mg/kg	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	5.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.4E+03	mg/kg	3.1E+00	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-04					NA
		Exposure Point Total									4.8E-04					NA

TABLE 7.24.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.1E-01	mg/kg	2.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.3E-07	NA	NA	NA	NA	NA
				Barium	2.0E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	2.1E+01	mg/kg	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.7E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.2E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.3E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.6E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.8E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.3E-07					NA
		Exposure Point Total									3.3E-07					NA
	Exposure Medium Total										4.9E-04					NA
Medium Total											1.1E-03					NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											5E-03					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.24.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
							Value					Value					
					Value	Units	0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs	Units	0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)	Units	Cancer Risk (3)
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	3.3E-03	mg/L	2.9E-06	5.8E-06	3.2E-06	3.2E-06	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	2.9E-05
			Dermal	Chromium (hexavalent)	3.3E-03	mg/L	3.1E-07	6.1E-07	1.3E-06	1.3E-06	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.1E-04
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	3.3E-03	mg/L	4.9E-06	9.7E-06	1.7E-05	1.7E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	7.2E-05
			Dermal	Chromium (hexavalent)	3.3E-03	mg/L	4.3E-08	8.6E-08	1.9E-07	1.9E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.9E-05
		Surface Water (Sweat Lodge)	Ingestion	Chromium (hexavalent)	3.3E-03	mg/L	n/a	1.2E-05	6.7E-06	6.7E-06	mg/kg-day	n/a	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	3.2E-05
			Dermal	Chromium (hexavalent)	3.3E-03	mg/L	n/a	1.6E-07	2.6E-07	2.6E-07	mg/kg-day	n/a	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	3.1E-05
		Water Vapor (Sweat Lodge)	Inhalation	Chromium (hexavalent)	5.4E-04	mg/m^3	n/a	1.3E-06	3.2E-06	3.2E-06	mg/m^3	n/a	2.5E-01	2.5E-01	8.4E-02	$1/(\mu g/m^3)$	1.4E-03

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
COPC = chemical of potential concern
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
$\mu g/m^3$= microgram per cubic meter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 7.25.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.2E+04	mg/kg	1.7E-02	mg/kg/day	NA	NA	NA	4.7E-02	mg/kg/day	1.0E+00	mg/kg/day	4.7E-02
				Antimony	3.0E+00	mg/kg	4.2E-06	mg/kg/day	NA	NA	NA	1.2E-05	mg/kg/day	4.0E-04	mg/kg/day	2.9E-02
				Arsenic	2.5E+01	mg/kg	2.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.2E-05	5.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Barium	1.9E+02	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	7.3E-04	mg/kg/day	2.0E-01	mg/kg/day	3.6E-03
				Beryllium	1.1E+00	mg/kg	1.6E-06	mg/kg/day	NA	NA	NA	4.5E-06	mg/kg/day	2.0E-03	mg/kg/day	2.2E-03
				Cadmium (non-water)	1.5E+02	mg/kg	2.1E-04	mg/kg/day	NA	NA	NA	5.8E-04	mg/kg/day	1.0E-03	mg/kg/day	5.8E-01
				Chromium (trivalent)	5.7E+01	mg/kg	7.9E-05	mg/kg/day	NA	NA	NA	2.2E-04	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04
				Cobalt	2.2E+01	mg/kg	3.1E-05	mg/kg/day	NA	NA	NA	8.6E-05	mg/kg/day	3.0E-04	mg/kg/day	2.9E-01
				Copper	1.5E+01	mg/kg	2.1E-05	mg/kg/day	NA	NA	NA	5.8E-05	mg/kg/day	4.0E-02	mg/kg/day	1.5E-03
				Iron	3.3E+04	mg/kg	4.7E-02	mg/kg/day	NA	NA	NA	1.3E-01	mg/kg/day	7.0E-01	mg/kg/day	1.9E-01
				Lead	2.7E+02	mg/kg	3.8E-04	mg/kg/day	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	3.2E-03	mg/kg/day	NA	NA	NA	8.8E-03	mg/kg/day	2.4E-02	mg/kg/day	3.7E-01
				Mercury (HgCl)	4.7E-01	mg/kg	6.5E-07	mg/kg/day	NA	NA	NA	1.8E-06	mg/kg/day	3.0E-04	mg/kg/day	6.1E-03
				Molybdenum	1.0E+02	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	3.9E-04	mg/kg/day	5.0E-03	mg/kg/day	7.8E-02
				Nickel	3.4E+01	mg/kg	4.7E-05	mg/kg/day	NA	NA	NA	1.3E-04	mg/kg/day	2.0E-02	mg/kg/day	6.6E-03
				Selenium	1.4E+01	mg/kg	2.0E-05	mg/kg/day	NA	NA	NA	5.5E-05	mg/kg/day	5.0E-03	mg/kg/day	1.1E-02
				Silica (as SIO2)	6.0E+03	mg/kg	8.4E-03	mg/kg/day	NA	NA	NA	2.4E-02	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	1.1E-05	mg/kg/day	NA	NA	NA	3.1E-05	mg/kg/day	5.0E-03	mg/kg/day	6.3E-03
				Thallium	1.3E+00	mg/kg	1.8E-06	mg/kg/day	NA	NA	NA	5.0E-06	mg/kg/day	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	4.6E-05	mg/kg/day	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.6E-02
				Zinc	2.4E+04	mg/kg	3.3E-02	mg/kg/day	NA	NA	NA	9.3E-02	mg/kg/day	3.0E-01	mg/kg/day	3.1E-01
			Exp. Route Total								3.2E-05					2.2E+00

TABLE 7.25.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	2.5E+01	mg/kg	5.2E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.8E-05	1.4E-05	mg/kg/day	3.0E-04	mg/kg/day	4.8E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.5E+02	mg/kg	1.0E-06	mg/kg/day	NA	NA	NA	2.9E-06	mg/kg/day	2.5E-05	mg/kg/day	1.1E-01
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								2.8E-05					1.6E-01
		Exposure Point Total									6.0E-05					2.3E+00
	Exposure Medium Total										6.0E-05					2.3E+00
Medium Total											6.0E-05					2.3E+00

TABLE 7.25.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Ingestion	Aluminum	1.4E+00	mg/L	2.7E-03	mg/kg/day	NA	NA	NA	7.6E-03	mg/kg/day	1.0E+00	mg/kg/day	7.6E-03
				Arsenic	8.4E-03	mg/L	1.6E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.4E-05	4.6E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	7.5E-02	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	4.0E-04	mg/kg/day	2.0E-01	mg/kg/day	2.0E-03
				Cadmium (water)	1.8E-03	mg/L	3.5E-06	mg/kg/day	NA	NA	NA	9.7E-06	mg/kg/day	5.0E-04	mg/kg/day	1.9E-02
				Chromium (hexavalent)	3.3E-03	mg/L	6.3E-06	mg/kg/day	5.0E-01	1/(mg/kg/day)	3.2E-06	1.8E-05	mg/kg/day	3.0E-03	mg/kg/day	5.9E-03
				Cobalt	7.9E-03	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	4.2E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Copper	6.4E-03	mg/L	1.2E-05	mg/kg/day	NA	NA	NA	3.4E-05	mg/kg/day	4.0E-02	mg/kg/day	8.6E-04
				Iron	1.8E+00	mg/L	3.5E-03	mg/kg/day	NA	NA	NA	9.7E-03	mg/kg/day	7.0E-01	mg/kg/day	1.4E-02
				Lead	1.1E-02	mg/L	2.0E-05	mg/kg/day	NA	NA	NA	5.7E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	4.4E-04	mg/kg/day	NA	NA	NA	1.2E-03	mg/kg/day	2.4E-02	mg/kg/day	5.1E-02
				Nickel	1.5E-02	mg/L	2.8E-05	mg/kg/day	NA	NA	NA	7.8E-05	mg/kg/day	2.0E-02	mg/kg/day	3.9E-03
				Selenium	2.0E-03	mg/L	3.9E-06	mg/kg/day	NA	NA	NA	1.1E-05	mg/kg/day	5.0E-03	mg/kg/day	2.2E-03
				Silica (as SIO2)	1.5E+01	mg/L	3.0E-02	mg/kg/day	NA	NA	NA	8.4E-02	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	6.6E-07	mg/kg/day	NA	NA	NA	1.8E-06	mg/kg/day	5.0E-03	mg/kg/day	3.7E-04
				Thallium	4.1E-04	mg/L	7.9E-07	mg/kg/day	NA	NA	NA	2.2E-06	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	1.4E-05	mg/kg/day	NA	NA	NA	4.0E-05	mg/kg/day	5.0E-03	mg/kg/day	8.0E-03
				Zinc	5.9E-01	mg/L	1.1E-03	mg/kg/day	NA	NA	NA	3.2E-03	mg/kg/day	3.0E-01	mg/kg/day	1.1E-02
			Exp. Route Total								2.8E-05					4.2E-01

TABLE 7.25.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Elm Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Dermal	Aluminum	1.4E+00	mg/L	5.8E-04	mg/kg/day	NA	NA	NA	1.6E-03	mg/kg/day	1.0E+00	mg/kg/day	1.6E-03
				Arsenic	8.4E-03	mg/L	3.5E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.2E-06	9.7E-06	mg/kg/day	3.0E-04	mg/kg/day	3.2E-02
				Barium	7.5E-02	mg/L	3.1E-05	mg/kg/day	NA	NA	NA	8.6E-05	mg/kg/day	1.4E-02	mg/kg/day	6.2E-03
				Cadmium (water)	1.8E-03	mg/L	7.4E-07	mg/kg/day	NA	NA	NA	2.1E-06	mg/kg/day	2.5E-05	mg/kg/day	8.3E-02
				Chromium (hexavalent)	3.3E-03	mg/L	2.7E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	5.4E-05	7.6E-06	mg/kg/day	7.5E-05	mg/kg/day	1.0E-01
				Cobalt	7.9E-03	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	3.6E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Copper	6.4E-03	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	7.3E-06	mg/kg/day	4.0E-02	mg/kg/day	1.8E-04
				Iron	1.8E+00	mg/L	7.4E-04	mg/kg/day	NA	NA	NA	2.1E-03	mg/kg/day	7.0E-01	mg/kg/day	2.9E-03
				Lead	1.1E-02	mg/L	4.4E-07	mg/kg/day	NA	NA	NA	1.2E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	9.4E-05	mg/kg/day	NA	NA	NA	2.6E-04	mg/kg/day	9.6E-04	mg/kg/day	2.7E-01
				Nickel	1.5E-02	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	3.3E-06	mg/kg/day	8.0E-04	mg/kg/day	4.2E-03
				Selenium	2.0E-03	mg/L	8.2E-07	mg/kg/day	NA	NA	NA	2.3E-06	mg/kg/day	5.0E-03	mg/kg/day	4.6E-04
				Silica (as SIO2)	1.5E+01	mg/L	6.4E-03	mg/kg/day	NA	NA	NA	1.8E-02	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	8.4E-08	mg/kg/day	NA	NA	NA	2.4E-07	mg/kg/day	2.0E-04	mg/kg/day	1.2E-03
				Thallium	4.1E-04	mg/L	1.7E-07	mg/kg/day	NA	NA	NA	4.7E-07	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	3.0E-06	mg/kg/day	NA	NA	NA	8.5E-06	mg/kg/day	1.3E-04	mg/kg/day	6.5E-02
				Zinc	5.9E-01	mg/L	1.5E-04	mg/kg/day	NA	NA	NA	4.1E-04	mg/kg/day	3.0E-01	mg/kg/day	1.4E-03
			Exp. Route Total								5.9E-05					5.8E-01
		Exposure Point Total									8.7E-05					1.0E+00
	Exposure Medium Total										8.7E-05					1.0E+00
Medium Total											8.7E-05					1.0E+00
Receptor Total (Sediment + Surface Water)											1E-04					3E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.25.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Exposure Scenario: Work Activities

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)
Aluminum	1.4E+00	1.0E-03	6.0	8.4E-06
Arsenic	8.4E-03	1.0E-03	6.0	5.1E-08
Barium	7.5E-02	1.0E-03	6.0	4.5E-07
Cadmium (water)	1.8E-03	1.0E-03	6.0	1.1E-08
Chromium (hexavalent)	3.3E-03	2.0E-03	6.0	3.9E-08
Cobalt	7.9E-03	4.0E-04	6.0	1.9E-08
Copper	6.4E-03	1.0E-03	6.0	3.8E-08
Iron	1.8E+00	1.0E-03	6.0	1.1E-05
Lead	1.1E-02	1.0E-04	6.0	6.4E-09
Manganese (non-diet)	2.3E-01	1.0E-03	6.0	1.4E-06
Nickel	1.5E-02	2.0E-04	6.0	1.7E-08
Selenium	2.0E-03	1.0E-03	6.0	1.2E-08
Silica (as SIO2)	1.5E+01	1.0E-03	6.0	9.3E-05
Silver	3.4E-04	6.0E-04	6.0	1.2E-09
Thallium	4.1E-04	1.0E-03	6.0	2.5E-09
Vanadium	7.4E-03	1.0E-03	6.0	4.4E-08
Zinc	5.9E-01	6.0E-04	6.0	2.1E-06

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event =milligram per square centimeter per event
mg/L = milligram per liter

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	2.9E-07	mg/kg/day	4.0E-04	mg/kg/day	7.2E-04
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	3.0E-04	mg/kg/day	4.8E-03
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	2.0E-01	mg/kg/day	8.9E-05
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	2.0E-03	mg/kg/day	5.5E-05
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E-03	mg/kg/day	1.4E-02
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	5.5E-06	mg/kg/day	1.5E+00	mg/kg/day	3.6E-06
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	2.1E-06	mg/kg/day	3.0E-04	mg/kg/day	7.1E-03
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	4.0E-02	mg/kg/day	3.6E-05
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	7.0E-01	mg/kg/day	4.6E-03
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	2.4E-02	mg/kg/day	9.0E-03
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-08	mg/kg/day	3.0E-04	mg/kg/day	1.5E-04
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	9.6E-06	mg/kg/day	5.0E-03	mg/kg/day	1.9E-03
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	2.0E-02	mg/kg/day	1.6E-04
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	5.0E-03	mg/kg/day	2.7E-04
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	7.7E-07	mg/kg/day	5.0E-03	mg/kg/day	1.5E-04
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	5.0E-03	mg/kg/day	6.3E-04
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	3.0E-01	mg/kg/day	7.6E-03
			Exp. Route Total								NA					5.3E-02

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	6.0E-08	mg/kg/day	2.5E-05	mg/kg/day	2.4E-03
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					3.4E-03
		Exposure Point Total									NA					5.6E-02
	Exposure Medium Total										NA					5.6E-02
Medium Total											NA					5.6E-02

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E+00	mg/kg/day	1.2E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	7.4E-07	mg/kg/day	3.0E-04	mg/kg/day	2.5E-03
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	6.6E-06	mg/kg/day	2.0E-01	mg/kg/day	3.3E-05
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	5.0E-04	mg/kg/day	3.2E-04
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	2.9E-07	mg/kg/day	3.0E-03	mg/kg/day	9.6E-05
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	6.9E-07	mg/kg/day	3.0E-04	mg/kg/day	2.3E-03
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	5.6E-07	mg/kg/day	4.0E-02	mg/kg/day	1.4E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	7.0E-01	mg/kg/day	2.3E-04
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	9.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	2.4E-02	mg/kg/day	8.3E-04
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	2.0E-02	mg/kg/day	6.4E-05
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	5.0E-03	mg/kg/day	3.5E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	3.0E-08	mg/kg/day	5.0E-03	mg/kg/day	6.0E-06
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	3.6E-08	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	6.5E-07	mg/kg/day	5.0E-03	mg/kg/day	1.3E-04
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	5.2E-05	mg/kg/day	3.0E-01	mg/kg/day	1.7E-04
			Exp. Route Total								NA					6.8E-03

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	1.0E+00	mg/kg/day	2.6E-05
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	3.0E-04	mg/kg/day	5.3E-04
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	1.4E-02	mg/kg/day	1.0E-04
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	3.4E-08	mg/kg/day	2.5E-05	mg/kg/day	1.3E-03
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	7.5E-05	mg/kg/day	1.6E-03
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	5.9E-08	mg/kg/day	3.0E-04	mg/kg/day	2.0E-04
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	4.0E-02	mg/kg/day	3.0E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	7.0E-01	mg/kg/day	4.8E-05
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	2.0E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	4.3E-06	mg/kg/day	9.6E-04	mg/kg/day	4.5E-03
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	5.5E-08	mg/kg/day	8.0E-04	mg/kg/day	6.8E-05
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	3.8E-08	mg/kg/day	5.0E-03	mg/kg/day	7.5E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	3.8E-09	mg/kg/day	2.0E-04	mg/kg/day	1.9E-05
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	7.7E-09	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	1.3E-04	mg/kg/day	1.1E-03
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	6.6E-06	mg/kg/day	3.0E-01	mg/kg/day	2.2E-05
			Exp. Route Total								NA					9.5E-03
		Exposure Point Total									NA					1.6E-02

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	1.0E+00	mg/kg/day	1.6E-05
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	9.8E-08	mg/kg/day	3.0E-04	mg/kg/day	3.3E-04
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	8.6E-07	mg/kg/day	1.4E-02	mg/kg/day	6.2E-05
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	2.1E-08	mg/kg/day	2.5E-05	mg/kg/day	8.3E-04
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	7.6E-08	mg/kg/day	7.5E-05	mg/kg/day	1.0E-03
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	3.6E-08	mg/kg/day	3.0E-04	mg/kg/day	1.2E-04
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	7.4E-08	mg/kg/day	4.0E-02	mg/kg/day	1.8E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	7.0E-01	mg/kg/day	3.0E-05
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	1.2E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	9.6E-04	mg/kg/day	2.7E-03
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	3.4E-08	mg/kg/day	8.0E-04	mg/kg/day	4.2E-05
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	2.3E-08	mg/kg/day	5.0E-03	mg/kg/day	4.6E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	2.4E-09	mg/kg/day	2.0E-04	mg/kg/day	1.2E-05
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	4.7E-09	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	8.5E-08	mg/kg/day	1.3E-04	mg/kg/day	6.6E-04
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	4.1E-06	mg/kg/day	3.0E-01	mg/kg/day	1.4E-05
			Exp. Route Total								NA					5.9E-03
		Exposure Point Total									NA					5.9E-03

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	4.2E-02	mg/kg/day	1.0E+00	mg/kg/day	4.2E-02
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-04	mg/kg/day	8.4E-01
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	2.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.4E-05	mg/kg/day	5.0E-04	mg/kg/day	1.1E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	9.8E-05	mg/kg/day	3.0E-03	mg/kg/day	3.3E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	2.4E-04	mg/kg/day	3.0E-04	mg/kg/day	7.8E-01
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	4.0E-02	mg/kg/day	4.8E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.4E-02	mg/kg/day	7.0E-01	mg/kg/day	7.7E-02
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	6.8E-03	mg/kg/day	2.4E-02	mg/kg/day	2.8E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	4.3E-04	mg/kg/day	2.0E-02	mg/kg/day	2.2E-02
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	5.0E-03	mg/kg/day	1.2E-02
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	5.0E-03	mg/kg/day	2.0E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	5.0E-03	mg/kg/day	4.4E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	1.8E-02	mg/kg/day	3.0E-01	mg/kg/day	5.9E-02
			Exp. Route Total								NA					2.3E+00

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	1.0E+00	mg/kg/day	2.3E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	3.0E-04	mg/kg/day	4.7E-03
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.4E-02	mg/kg/day	8.9E-04
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	2.5E-05	mg/kg/day	1.2E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	7.5E-05	mg/kg/day	1.5E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	5.3E-07	mg/kg/day	3.0E-04	mg/kg/day	1.8E-03
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	4.0E-02	mg/kg/day	2.7E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	7.0E-01	mg/kg/day	4.3E-04
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	9.6E-04	mg/kg/day	4.0E-02
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	4.9E-07	mg/kg/day	8.0E-04	mg/kg/day	6.1E-04
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	3.3E-07	mg/kg/day	5.0E-03	mg/kg/day	6.7E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	3.4E-08	mg/kg/day	2.0E-04	mg/kg/day	1.7E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	6.8E-08	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	1.3E-04	mg/kg/day	9.5E-03
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	3.0E-01	mg/kg/day	2.0E-04
			Exp. Route Total								NA					8.5E-02
		Exposure Point Total									NA					2.4E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					2.4E+00
	Exposure Medium Total (Wading + Potable Use)										NA					2.4E+00
Medium Total (Swimming + Potable Use)											NA					2.4E+00
Medium Total (Wading + Potable Use)											NA					2.4E+00

TABLE 7.26.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-04	mg/kg/day	5.1E-01
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.1E-02
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	9.9E-06	mg/kg/day	2.0E-03	mg/kg/day	4.9E-03
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.0E-03	mg/kg/day	3.1E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	1.9E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	7.0E-01	mg/kg/day	4.5E-03
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	1.4E-01	mg/kg/day	1.2E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	1.0E-04	mg/kg/day	4.2E-01
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.6E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	3.0E-01	mg/kg/day	2.9E-02
			Exp. Route Total								NA					1.5E+00
		Exposure Point Total									NA					1.5E+00
	Exposure Medium Total										NA					1.5E+00
Medium Total											NA					1.5E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					4E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					4E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.26.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.4E+00	1.0E-03	1.0	1.4E-06	1.0	1.4E-06	2.9E-01
Arsenic	8.4E-03	1.0E-03	1.0	8.4E-09	1.0	8.4E-09	1.8E-03
Barium	7.5E-02	1.0E-03	1.0	7.5E-08	1.0	7.5E-08	1.6E-02
Cadmium (water)	1.8E-03	1.0E-03	1.0	1.8E-09	1.0	1.8E-09	3.7E-04
Chromium (hexavalent)	3.3E-03	2.0E-03	1.0	6.6E-09	1.0	6.6E-09	1.4E-03
Cobalt	7.9E-03	4.0E-04	1.0	3.1E-09	1.0	3.1E-09	6.6E-04
Copper	6.4E-03	1.0E-03	1.0	6.4E-09	1.0	6.4E-09	1.3E-03
Iron	1.8E+00	1.0E-03	1.0	1.8E-06	1.0	1.8E-06	3.7E-01
Lead	1.1E-02	1.0E-04	1.0	1.1E-09	1.0	1.1E-09	2.2E-04
Manganese (non-diet)	2.3E-01	1.0E-03	1.0	2.3E-07	1.0	2.3E-07	4.7E-02
Nickel	1.5E-02	2.0E-04	1.0	2.9E-09	1.0	2.9E-09	6.1E-04
Selenium	2.0E-03	1.0E-03	1.0	2.0E-09	1.0	2.0E-09	4.2E-04
Silica (as SIO2)	1.5E+01	1.0E-03	1.0	1.5E-05	1.0	1.5E-05	3.2E+00
Silver	3.4E-04	6.0E-04	1.0	2.0E-10	1.0	2.0E-10	4.3E-05
Thallium	4.1E-04	1.0E-03	1.0	4.1E-10	1.0	4.1E-10	8.5E-05
Vanadium	7.4E-03	1.0E-03	1.0	7.4E-09	1.0	7.4E-09	1.5E-03
Zinc	5.9E-01	6.0E-04	1.0	3.5E-07	1.0	3.5E-07	7.4E-02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.26.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Wading

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	6,032	2,373
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.4E+00	1.0E-03	2.0	2.8E-06	2.0	2.8E-06	1.9E-01
Arsenic	8.4E-03	1.0E-03	2.0	1.7E-08	2.0	1.7E-08	1.2E-03
Barium	7.5E-02	1.0E-03	2.0	1.5E-07	2.0	1.5E-07	1.0E-02
Cadmium (water)	1.8E-03	1.0E-03	2.0	3.6E-09	2.0	3.6E-09	2.5E-04
Chromium (hexavalent)	3.3E-03	2.0E-03	2.0	1.3E-08	2.0	1.3E-08	9.0E-04
Cobalt	7.9E-03	4.0E-04	2.0	6.3E-09	2.0	6.3E-09	4.3E-04
Copper	6.4E-03	1.0E-03	2.0	1.3E-08	2.0	1.3E-08	8.8E-04
Iron	1.8E+00	1.0E-03	2.0	3.6E-06	2.0	3.6E-06	2.5E-01
Lead	1.1E-02	1.0E-04	2.0	2.1E-09	2.0	2.1E-09	1.5E-04
Manganese (non-diet)	2.3E-01	1.0E-03	2.0	4.5E-07	2.0	4.5E-07	3.1E-02
Nickel	1.5E-02	2.0E-04	2.0	5.8E-09	2.0	5.8E-09	4.0E-04
Selenium	2.0E-03	1.0E-03	2.0	4.0E-09	2.0	4.0E-09	2.8E-04
Silica (as SIO2)	1.5E+01	1.0E-03	2.0	3.1E-05	2.0	3.1E-05	2.1E+00
Silver	3.4E-04	6.0E-04	2.0	4.1E-10	2.0	4.1E-10	2.8E-05
Thallium	4.1E-04	1.0E-03	2.0	8.2E-10	2.0	8.2E-10	5.6E-05
Vanadium	7.4E-03	1.0E-03	2.0	1.5E-08	2.0	1.5E-08	1.0E-03
Zinc	5.9E-01	6.0E-04	2.0	7.0E-07	2.0	7.0E-07	4.8E-02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.26.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	350	350
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.4E+00	1.0E-03	0.71	1.0E-06	0.54	7.6E-07	2.4E+00
Arsenic	8.4E-03	1.0E-03	0.71	6.0E-09	0.54	4.6E-09	1.4E-02
Barium	7.5E-02	1.0E-03	0.71	5.3E-08	0.54	4.0E-08	1.3E-01
Cadmium (water)	1.8E-03	1.0E-03	0.71	1.3E-09	0.54	9.7E-10	3.0E-03
Chromium (hexavalent)	3.3E-03	2.0E-03	0.71	4.7E-09	0.54	3.5E-09	1.1E-02
Cobalt	7.9E-03	4.0E-04	0.71	2.2E-09	0.54	1.7E-09	5.3E-03
Copper	6.4E-03	1.0E-03	0.71	4.5E-09	0.54	3.4E-09	1.1E-02
Iron	1.8E+00	1.0E-03	0.71	1.3E-06	0.54	9.7E-07	3.0E+00
Lead	1.1E-02	1.0E-04	0.71	7.5E-10	0.54	5.7E-10	1.8E-03
Manganese (non-diet)	2.3E-01	1.0E-03	0.71	1.6E-07	0.54	1.2E-07	3.9E-01
Nickel	1.5E-02	2.0E-04	0.71	2.1E-09	0.54	1.6E-09	4.9E-03
Selenium	2.0E-03	1.0E-03	0.71	1.4E-09	0.54	1.1E-09	3.4E-03
Silica (as SIO2)	1.5E+01	1.0E-03	0.71	1.1E-05	0.54	8.4E-06	2.6E+01
Silver	3.4E-04	6.0E-04	0.71	1.4E-10	0.54	1.1E-10	3.5E-04
Thallium	4.1E-04	1.0E-03	0.71	2.9E-10	0.54	2.2E-10	7.0E-04
Vanadium	7.4E-03	1.0E-03	0.71	5.2E-09	0.54	4.0E-09	1.3E-02
Zinc	5.9E-01	6.0E-04	0.71	2.5E-07	0.54	1.9E-07	6.0E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	1.0E+00	mg/kg/day	1.2E-02
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-06	mg/kg/day	4.0E-04	mg/kg/day	7.7E-03
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	3.0E-04	mg/kg/day	5.1E-02
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	2.0E-01	mg/kg/day	9.5E-04
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	2.0E-03	mg/kg/day	5.9E-04
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	1.0E-03	mg/kg/day	1.5E-01
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	5.8E-05	mg/kg/day	1.5E+00	mg/kg/day	3.9E-05
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-05	mg/kg/day	3.0E-04	mg/kg/day	7.5E-02
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	4.0E-02	mg/kg/day	3.8E-04
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	3.4E-02	mg/kg/day	7.0E-01	mg/kg/day	4.9E-02
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	2.4E-02	mg/kg/day	9.6E-02
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	4.8E-07	mg/kg/day	3.0E-04	mg/kg/day	1.6E-03
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	5.0E-03	mg/kg/day	2.0E-02
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	3.5E-05	mg/kg/day	2.0E-02	mg/kg/day	1.7E-03
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	5.0E-03	mg/kg/day	2.9E-03
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	6.2E-03	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	8.2E-06	mg/kg/day	5.0E-03	mg/kg/day	1.6E-03
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	5.0E-03	mg/kg/day	6.8E-03
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	2.4E-02	mg/kg/day	3.0E-01	mg/kg/day	8.1E-02
			Exp. Route Total								NA					5.6E-01

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	2.5E+01	mg/kg	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	3.0E-04	mg/kg/day	6.1E-03
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.5E+02	mg/kg	NA	NA	NA	NA	NA	3.6E-07	mg/kg/day	2.5E-05	mg/kg/day	1.4E-02
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					2.1E-02
		Exposure Point Total									NA					5.8E-01
	Exposure Medium Total										NA					5.8E-01
Medium Total											NA					5.8E-01

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	8.6E-04	mg/kg/day	1.0E+00	mg/kg/day	8.6E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	5.2E-06	mg/kg/day	3.0E-04	mg/kg/day	1.7E-02
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	2.0E-01	mg/kg/day	2.3E-04
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	5.0E-04	mg/kg/day	2.2E-03
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	2.0E-06	mg/kg/day	3.0E-03	mg/kg/day	6.7E-04
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	4.8E-06	mg/kg/day	3.0E-04	mg/kg/day	1.6E-02
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	4.0E-02	mg/kg/day	9.8E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	7.0E-01	mg/kg/day	1.6E-03
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	6.5E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	2.4E-02	mg/kg/day	5.8E-03
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	8.9E-06	mg/kg/day	2.0E-02	mg/kg/day	4.4E-04
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	5.0E-03	mg/kg/day	2.5E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	9.5E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	5.0E-03	mg/kg/day	4.2E-05
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	2.5E-07	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	4.5E-06	mg/kg/day	5.0E-03	mg/kg/day	9.1E-04
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	3.0E-01	mg/kg/day	1.2E-03
			Exp. Route Total								NA					4.8E-02

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E+00	mg/kg/day	4.6E-05
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	2.7E-07	mg/kg/day	3.0E-04	mg/kg/day	9.1E-04
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	1.4E-02	mg/kg/day	1.7E-04
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.8E-08	mg/kg/day	2.5E-05	mg/kg/day	2.3E-03
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	7.5E-05	mg/kg/day	2.8E-03
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	3.0E-04	mg/kg/day	3.4E-04
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	4.0E-02	mg/kg/day	5.2E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.8E-05	mg/kg/day	7.0E-01	mg/kg/day	8.3E-05
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	3.5E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	7.4E-06	mg/kg/day	9.6E-04	mg/kg/day	7.7E-03
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	9.4E-08	mg/kg/day	8.0E-04	mg/kg/day	1.2E-04
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	6.5E-08	mg/kg/day	5.0E-03	mg/kg/day	1.3E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	6.6E-09	mg/kg/day	2.0E-04	mg/kg/day	3.3E-05
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	1.3E-08	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	1.3E-04	mg/kg/day	1.8E-03
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	3.0E-01	mg/kg/day	3.8E-05
			Exp. Route Total								NA					1.6E-02
		Exposure Point Total									NA					6.4E-02

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	1.0E+00	mg/kg/day	3.4E-05
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	3.0E-04	mg/kg/day	6.8E-04
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	1.4E-02	mg/kg/day	1.3E-04
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	4.3E-08	mg/kg/day	2.5E-05	mg/kg/day	1.7E-03
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	7.5E-05	mg/kg/day	2.1E-03
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	7.6E-08	mg/kg/day	3.0E-04	mg/kg/day	2.5E-04
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	4.0E-02	mg/kg/day	3.9E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	4.3E-05	mg/kg/day	7.0E-01	mg/kg/day	6.2E-05
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	2.6E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	5.5E-06	mg/kg/day	9.6E-04	mg/kg/day	5.7E-03
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	7.0E-08	mg/kg/day	8.0E-04	mg/kg/day	8.8E-05
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	4.9E-08	mg/kg/day	5.0E-03	mg/kg/day	9.7E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	5.0E-09	mg/kg/day	2.0E-04	mg/kg/day	2.5E-05
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	9.9E-09	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	1.3E-04	mg/kg/day	1.4E-03
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	8.5E-06	mg/kg/day	3.0E-01	mg/kg/day	2.8E-05
			Exp. Route Total								NA					1.2E-02
		Exposure Point Total									NA					1.2E-02

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	7.0E-02	mg/kg/day	1.0E+00	mg/kg/day	7.0E-02
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	3.0E-04	mg/kg/day	1.4E+00
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	2.0E-01	mg/kg/day	1.9E-02
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	8.9E-05	mg/kg/day	5.0E-04	mg/kg/day	1.8E-01
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-03	mg/kg/day	5.5E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	3.0E-04	mg/kg/day	1.3E+00
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	4.0E-02	mg/kg/day	7.9E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	8.9E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	5.3E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	2.4E-02	mg/kg/day	4.7E-01
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	2.0E-02	mg/kg/day	3.6E-02
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	5.0E-03	mg/kg/day	2.0E-02
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	7.7E-01	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	5.0E-03	mg/kg/day	3.4E-03
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	3.7E-04	mg/kg/day	5.0E-03	mg/kg/day	7.4E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	2.9E-02	mg/kg/day	3.0E-01	mg/kg/day	9.8E-02
			Exp. Route Total								NA					3.9E+00

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	1.0E+00	mg/kg/day	3.1E-04
				Arsenic	8.4E-03	mg/L	NA	NA	NA	NA	NA	1.9E-06	mg/kg/day	3.0E-04	mg/kg/day	6.2E-03
				Barium	7.5E-02	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	1.4E-02	mg/kg/day	1.2E-03
				Cadmium (water)	1.8E-03	mg/L	NA	NA	NA	NA	NA	3.9E-07	mg/kg/day	2.5E-05	mg/kg/day	1.6E-02
				Chromium (hexavalent)	3.3E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	7.5E-05	mg/kg/day	1.9E-02
				Cobalt	7.9E-03	mg/L	NA	NA	NA	NA	NA	6.9E-07	mg/kg/day	3.0E-04	mg/kg/day	2.3E-03
				Copper	6.4E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	4.0E-02	mg/kg/day	3.5E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	7.0E-01	mg/kg/day	5.6E-04
				Lead	1.1E-02	mg/L	NA	NA	NA	NA	NA	2.3E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	NA	NA	NA	NA	NA	5.0E-05	mg/kg/day	9.6E-04	mg/kg/day	5.2E-02
				Nickel	1.5E-02	mg/L	NA	NA	NA	NA	NA	6.4E-07	mg/kg/day	8.0E-04	mg/kg/day	8.0E-04
				Selenium	2.0E-03	mg/L	NA	NA	NA	NA	NA	4.4E-07	mg/kg/day	5.0E-03	mg/kg/day	8.8E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	NA	NA	NA
				Silver	3.4E-04	mg/L	NA	NA	NA	NA	NA	4.5E-08	mg/kg/day	2.0E-04	mg/kg/day	2.2E-04
				Thallium	4.1E-04	mg/L	NA	NA	NA	NA	NA	9.0E-08	mg/kg/day	NA	NA	NA
				Vanadium	7.4E-03	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	1.3E-04	mg/kg/day	1.2E-02
				Zinc	5.9E-01	mg/L	NA	NA	NA	NA	NA	7.7E-05	mg/kg/day	3.0E-01	mg/kg/day	2.6E-04
			Exp. Route Total								NA					1.1E-01
		Exposure Point Total									NA					4.0E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					4.0E+00
	Exposure Medium Total (Wading + Potable Use)										NA					4.0E+00
Medium Total (Swimming + Potable Use)											NA					4.0E+00
Medium Total (Wading + Potable Use)											NA					4.0E+00

TABLE 7.27.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	1.0E+00	mg/kg/day	3.1E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	4.0E-04	mg/kg/day	1.4E+00
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	7.4E-04	mg/kg/day	2.0E-01	mg/kg/day	3.7E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	1.0E-03	mg/kg/day	8.3E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	1.5E+00	mg/kg/day	5.0E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	4.0E-02	mg/kg/day	2.8E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	8.4E-03	mg/kg/day	7.0E-01	mg/kg/day	1.2E-02
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	1.4E-01	mg/kg/day	3.1E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-04	mg/kg/day	1.1E+00
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.4E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	5.0E-03	mg/kg/day	7.0E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	3.0E-01	mg/kg/day	7.8E-02
			Exp. Route Total								NA					3.9E+00
		Exposure Point Total									NA					3.9E+00
	Exposure Medium Total										NA					3.9E+00
Medium Total											NA					3.9E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					9E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					8E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.2E+04	mg/kg	1.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.0E+00	mg/kg	3.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	2.5E+01	mg/kg	1.7E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.6E-06	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	2.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E+00	mg/kg	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+02	mg/kg	1.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.7E+01	mg/kg	6.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.2E+01	mg/kg	2.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.3E+04	mg/kg	3.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	2.7E+02	mg/kg	3.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.7E-01	mg/kg	5.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.4E+01	mg/kg	3.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	1.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.0E+03	mg/kg	6.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	9.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.3E+00	mg/kg	1.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	3.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.4E+04	mg/kg	2.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.6E-06					NA

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.2E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	2.5E+01	mg/kg	2.4E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.7E-07	NA	NA	NA	NA	NA
				Barium	1.9E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+02	mg/kg	4.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.7E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.3E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	2.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	4.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	1.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.7E-07					NA
		Exposure Point Total									3.0E-06					NA
	Exposure Medium Total										3.0E-06					NA
Medium Total											3.0E-06					NA

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.4E+00	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	6.6E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	9.8E-07	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	5.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	1.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	2.6E-07	mg/kg/day	5.0E-01	1/(mg/kg/day)	5.4E-07	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	6.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	5.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	8.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	1.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	2.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	3.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	5.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	4.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.5E-06					NA

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.4E+00	mg/L	1.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	6.9E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.0E-07	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	6.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	1.5E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	5.4E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	3.4E-06	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	2.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	5.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	8.7E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	1.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	2.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	1.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	1.7E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	3.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	6.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.5E-06					NA
		Exposure Point Total									5.0E-06					NA

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	1.4E+00	mg/L	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	4.5E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-08	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	4.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	9.6E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	3.5E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.3E-06	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	1.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	3.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	9.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	5.7E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	1.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	1.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	8.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	1.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	2.2E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	4.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	1.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.4E-06					NA
		Exposure Point Total									2.4E-06					NA

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.4E+00	mg/L	1.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	1.1E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.6E-04	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	9.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	4.2E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	6.5E-05	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	8.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	2.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	2.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	2.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	2.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	4.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	5.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	7.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.3E-04					NA

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.4E+00	mg/L	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	8.4E-03	mg/L	5.6E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	8.4E-07	NA	NA	NA	NA	NA
				Barium	7.5E-02	mg/L	5.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.8E-03	mg/L	1.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.3E-03	mg/L	4.4E-07	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.7E-05	NA	NA	NA	NA	NA
				Cobalt	7.9E-03	mg/L	2.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.4E-03	mg/L	4.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E-02	mg/L	7.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.3E-01	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E-02	mg/L	1.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	2.0E-03	mg/L	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	3.4E-04	mg/L	1.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.1E-04	mg/L	2.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	7.4E-03	mg/L	4.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	5.9E-01	mg/L	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.8E-05					NA
		Exposure Point Total									2.6E-04					NA
	Exposure Medium Total (Swimming + Potable Use)										2.6E-04					NA
	Exposure Medium Total (Wading + Potable Use)										2.6E-04					NA
Medium Total (Swimming + Potable Use)											2.6E-04					NA
Medium Total (Wading + Potable Use)											2.6E-04					NA

TABLE 7.28.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	5.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.3E-02	mg/kg	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	NA	NA	NA	NA	NA
				Barium	3.3E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E-02	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.7E-02	mg/kg	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.4E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.0E-02	mg/kg	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.0E-01	mg/kg	4.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	8.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.0E-02	mg/kg	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	7.6E-02	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.0E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.6E-01	mg/kg	6.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	6.9E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.0E+01	mg/kg	4.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.1E-05					NA
		Exposure Point Total									2.1E-05					NA
	Exposure Medium Total										2.1E-05					NA
Medium Total											2.1E-05					NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)											3E-04					NA
Receptor Total (Sediment + Wading + Potable Use + Fish)											3E-04					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.28.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Beaver Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations										
							Intake					CSF/Unit Risk					
							Value					Value					
					Value	Units	0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs	Units	0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)	Units	Cancer Risk (3)
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	3.3E-03	mg/L	5.8E-08	1.2E-07	4.1E-08	4.1E-08	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	5.4E-07
			Dermal	Chromium (hexavalent)	3.3E-03	mg/L	6.1E-09	1.2E-08	1.8E-08	1.8E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	3.4E-06
		Surface Water (Rivers & Creeks) Wading	Dermal	Chromium (hexavalent)	3.3E-03	mg/L	4.5E-09	9.1E-09	1.1E-08	1.1E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.3E-06
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	3.3E-03	mg/L	4.7E-06	9.3E-06	1.4E-05	1.4E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	6.5E-05
			Dermal	Chromium (hexavalent)	3.3E-03	mg/L	5.4E-08	1.1E-07	1.2E-07	1.2E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.7E-05
Underground Mine	Underground Mine	Underground Mine	Dermal	Chromium (hexavalent)	NA	µg/L	#N/A	#N/A	#N/A	#N/A	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	#N/A

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
µg/L = microgram per liter

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	6.7E-02	mg/kg/day	1.0E+00	mg/kg/day	6.7E-02
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	4.0E-04	mg/kg/day	4.4E-02
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	3.0E-04	mg/kg/day	4.5E-02
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-04	mg/kg/day	2.0E-01	mg/kg/day	3.2E-03
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	2.0E-03	mg/kg/day	2.0E-03
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	7.0E-05	mg/kg/day	1.0E-03	mg/kg/day	7.0E-02
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.1E-04
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-05	mg/kg/day	3.0E-04	mg/kg/day	1.6E-01
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	5.2E-05	mg/kg/day	4.0E-02	mg/kg/day	1.3E-03
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	8.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.2E-01
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	8.2E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	2.4E-02	mg/kg/day	5.2E-01
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	3.0E-04	mg/kg/day	2.3E-02
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.7E-03
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	5.0E-03	mg/kg/day	3.7E-03
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	5.8E-06	mg/kg/day	5.0E-03	mg/kg/day	1.2E-03
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	5.0E-03	mg/kg/day	2.9E-02
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	9.6E-03	mg/kg/day	3.0E-01	mg/kg/day	3.2E-02
			Exp. Route Total								NA					1.1E+00

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	3.3E-06	mg/kg/day	3.0E-04	mg/kg/day	1.1E-02
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	2.5E-05	mg/kg/day	1.4E-02
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					2.5E-02
		Exposure Point Total									NA					1.1E+00
	Exposure Medium Total										NA					1.1E+00
Medium Total											NA					1.1E+00

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	1.0E+00	mg/kg/day	2.4E-03
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	2.0E-01	mg/kg/day	2.4E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	2.5E-07	mg/kg/day	5.0E-04	mg/kg/day	4.9E-04
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	4.0E-02	mg/kg/day	8.4E-03
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	2.1E-03	mg/kg/day	7.0E-01	mg/kg/day	3.1E-03
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	7.9E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	8.2E-04	mg/kg/day	2.4E-02	mg/kg/day	3.4E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	2.0E-02	mg/kg/day	6.1E-04
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	5.0E-03	mg/kg/day	5.4E-04
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	3.0E-01	mg/kg/day	1.0E-03
			Exp. Route Total								NA					5.3E-02
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	5.2E-04	mg/kg/day	1.0E+00	mg/kg/day	5.2E-04
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	1.4E-02	mg/kg/day	7.4E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	5.3E-08	mg/kg/day	2.5E-05	mg/kg/day	2.1E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	7.2E-05	mg/kg/day	4.0E-02	mg/kg/day	1.8E-03
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	7.0E-01	mg/kg/day	6.5E-04
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	9.6E-04	mg/kg/day	1.8E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	8.0E-04	mg/kg/day	6.5E-04
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	5.8E-07	mg/kg/day	1.3E-04	mg/kg/day	4.4E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	3.0E-01	mg/kg/day	1.3E-04
			Exp. Route Total								NA					2.0E-01
		Exposure Point Total									NA					2.5E-01

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	1.0E+00	mg/kg/day	1.3E-02
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.3E-02
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	5.0E-04	mg/kg/day	2.6E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	4.0E-02	mg/kg/day	4.5E-02
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	7.0E-01	mg/kg/day	1.6E-02
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	4.2E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	4.3E-03	mg/kg/day	2.4E-02	mg/kg/day	1.8E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	6.4E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	5.0E-03	mg/kg/day	2.9E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	3.0E-01	mg/kg/day	5.4E-03
			Exp. Route Total								NA					2.8E-01
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	7.1E-05	mg/kg/day	1.0E+00	mg/kg/day	7.1E-05
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.4E-02	mg/kg/day	1.0E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	7.3E-09	mg/kg/day	2.5E-05	mg/kg/day	2.9E-04
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	4.0E-02	mg/kg/day	2.5E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	7.0E-01	mg/kg/day	9.1E-05
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	9.6E-04	mg/kg/day	2.5E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	7.2E-08	mg/kg/day	8.0E-04	mg/kg/day	9.0E-05
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	8.0E-08	mg/kg/day	1.3E-04	mg/kg/day	6.1E-04
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	5.5E-06	mg/kg/day	3.0E-01	mg/kg/day	1.8E-05
			Exp. Route Total								NA					2.8E-02
		Exposure Point Total									NA					3.1E-01

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	5.1E-03	mg/kg/day	1.0E+00	mg/kg/day	5.1E-03
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	2.0E-01	mg/kg/day	5.2E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	5.0E-04	mg/kg/day	1.0E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	4.5E-03	mg/kg/day	7.0E-01	mg/kg/day	6.5E-03
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	2.4E-02	mg/kg/day	7.2E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-02	mg/kg/day	1.3E-03
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	5.7E-06	mg/kg/day	5.0E-03	mg/kg/day	1.1E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	6.5E-04	mg/kg/day	3.0E-01	mg/kg/day	2.2E-03
			Exp. Route Total								NA					1.1E-01
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	1.0E+00	mg/kg/day	1.0E-04
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.4E-02	mg/kg/day	1.4E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.0E-08	mg/kg/day	2.5E-05	mg/kg/day	4.1E-04
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	4.0E-02	mg/kg/day	3.5E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	8.9E-05	mg/kg/day	7.0E-01	mg/kg/day	1.3E-04
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.3E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	9.6E-04	mg/kg/day	3.5E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	8.0E-04	mg/kg/day	1.3E-04
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	1.3E-04	mg/kg/day	8.6E-04
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	7.7E-06	mg/kg/day	3.0E-01	mg/kg/day	2.6E-05
			Exp. Route Total								NA					3.9E-02
		Exposure Point Total									NA					1.5E-01

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	5.9E-02	mg/m^3	NA	NA	NA	NA	NA	2.5E-03	mg/m^3	5.0E-03	mg/m3	4.9E-01
				Barium	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	5.0E-04	mg/m^3	5.0E-04	mg/m3	1.0E+00
				Cadmium (water)	6.1E-06	mg/m^3	NA	NA	NA	NA	NA	2.5E-07	mg/m^3	1.0E-05	mg/m3	2.5E-02
				Copper	8.3E-03	mg/m^3	NA	NA	NA	NA	NA	3.5E-04	mg/m^3	NA	NA	NA
				Iron	5.3E-02	mg/m^3	NA	NA	NA	NA	NA	2.2E-03	mg/m^3	NA	NA	NA
				Lead	2.0E-02	mg/m^3	NA	NA	NA	NA	NA	8.2E-04	mg/m^3	NA	NA	NA
				Manganese (non-diet)	2.0E-02	mg/m^3	NA	NA	NA	NA	NA	8.4E-04	mg/m^3	5.0E-05	mg/m3	1.7E+01
				Nickel	3.0E-04	mg/m^3	NA	NA	NA	NA	NA	1.2E-05	mg/m^3	9.0E-05	mg/m3	1.4E-01
				Vanadium	6.6E-05	mg/m^3	NA	NA	NA	NA	NA	2.8E-06	mg/m^3	1.0E-04	mg/m3	2.8E-02
				Zinc	7.6E-03	mg/m^3	NA	NA	NA	NA	NA	3.2E-04	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					1.8E+01
		Exposure Point Total									NA					1.8E+01
	Exposure Medium Total										NA					1.9E+01
Medium Total											NA					1.9E+01

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	1.0E+00	mg/kg/day	6.6E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.8E-01
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.6E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-03	mg/kg/day	6.9E-03
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	1.0E-03	mg/kg/day	8.5E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	1.5E+00	mg/kg/day	3.9E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	7.0E-01	mg/kg/day	2.0E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.4E-01	mg/kg/day	7.6E-02
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	1.0E-04	mg/kg/day	5.3E-01
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	5.9E-03
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	5.0E-03	mg/kg/day	2.1E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	5.0E-03	mg/kg/day	6.7E-02
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-03	mg/kg/day	4.6E-02
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	3.0E-01	mg/kg/day	1.3E-01
			Exp. Route Total								NA					2.3E+00
		Exposure Point Total									NA					2.3E+00

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	6.0E-02	mg/kg/day	1.0E+00	mg/kg/day	6.0E-02
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-04	mg/kg/day	8.3E-01
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-02	mg/kg/day	2.0E-01	mg/kg/day	2.2E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-03	mg/kg/day	8.1E-02
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	1.0E-03	mg/kg/day	2.7E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.7E-02
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	4.0E-02	mg/kg/day	3.3E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	7.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.0E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	5.2E-01	mg/kg/day	1.4E-01	mg/kg/day	3.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	1.0E-04	mg/kg/day	5.1E-02
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.3E-03
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	5.0E-03	mg/kg/day	7.5E-01
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	5.0E-03	mg/kg/day	6.2E-02
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	3.0E-01	mg/kg/day	6.6E-01
			Exp. Route Total								NA					6.9E+00
		Exposure Point Total									NA					6.9E+00

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	1.5E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.3E-02
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.7E-03
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.0E-03	mg/kg/day	3.4E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.0E-03	mg/kg/day	2.0E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.0E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	5.0E-03
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-03	mg/kg/day	7.0E-01	mg/kg/day	4.0E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.4E-01	mg/kg/day	9.9E-03
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-06	mg/kg/day	1.0E-04	mg/kg/day	5.9E-02
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	2.0E-02	mg/kg/day	2.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	5.0E-03	mg/kg/day	5.7E-02
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	6.9E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-03	mg/kg/day	3.0E-01	mg/kg/day	3.1E-02
			Exp. Route Total								NA					2.8E-01
		Exposure Point Total									NA					2.8E-01

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	1.0E+00	mg/kg/day	4.8E-03
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.6E-01
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	2.0E-01	mg/kg/day	5.3E-04
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	2.0E-03	mg/kg/day	2.0E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E-03	mg/kg/day	4.6E-02
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	1.5E+00	mg/kg/day	2.1E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	4.0E-02	mg/kg/day	3.6E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	7.0E-01	mg/kg/day	5.4E-02
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	1.4E-01	mg/kg/day	2.4E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	1.0E-04	mg/kg/day	5.7E-01
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	2.0E-02	mg/kg/day	1.8E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					2.0E+00
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total										NA					1.1E+01

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	7.4E-01	mg/kg/day	1.0E+00	mg/kg/day	7.4E-01
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	3.0E-04	mg/kg/day	9.7E-01
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	2.0E-01	mg/kg/day	2.0E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	2.0E-03	mg/kg/day	3.9E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	1.0E-03	mg/kg/day	2.8E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	1.5E+00	mg/kg/day	3.4E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	7.1E-03	mg/kg/day	3.0E-04	mg/kg/day	2.4E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-02	mg/kg/day	4.0E-02	mg/kg/day	9.1E-01
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+01	mg/kg/day	7.0E-01	mg/kg/day	1.7E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	5.7E-01	mg/kg/day	1.4E-01	mg/kg/day	4.1E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	8.6E-05	mg/kg/day	1.0E-04	mg/kg/day	8.6E-01
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-02	mg/kg/day	1.6E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.5E-02
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	5.0E-03	mg/kg/day	9.5E-01
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+00	mg/kg/day	3.0E-01	mg/kg/day	9.1E+00
			Exp. Route Total								NA					8.8E+01
		Exposure Point Total									NA					8.8E+01

TABLE 7.29.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	3.0E-04	mg/kg/day	7.2E-04
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	2.5E-05	mg/kg/day	6.7E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.4E-03
		Exposure Point Total									NA					7.4E-03
	Exposure Medium Total										NA					8.8E+01
Medium Total											NA					1.0E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					1E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.29.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	312	234
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	3.6E-01	1.0E-03	6.0	2.1E-06	6.0	2.1E-06	1.3E+01
Barium	7.2E-02	1.0E-03	6.0	4.3E-07	6.0	4.3E-07	2.7E+00
Cadmium (water)	3.7E-05	1.0E-03	6.0	2.2E-10	6.0	2.2E-10	1.4E-03
Copper	5.0E-02	1.0E-03	6.0	3.0E-07	6.0	3.0E-07	1.9E+00
Iron	3.2E-01	1.0E-03	6.0	1.9E-06	6.0	1.9E-06	1.2E+01
Lead	1.2E-01	1.0E-04	6.0	7.1E-08	6.0	7.1E-08	4.4E-01
Manganese (non-diet)	1.2E-01	1.0E-03	6.0	7.3E-07	6.0	7.3E-07	4.5E+00
Nickel	1.8E-03	2.0E-04	6.0	2.2E-09	6.0	2.2E-09	1.3E-02
Vanadium	4.0E-04	1.0E-03	6.0	2.4E-09	6.0	2.4E-09	1.5E-02
Zinc	4.6E-02	6.0E-04	6.0	1.6E-07	6.0	1.6E-07	1.0E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.29.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	3.6E-01	1.0E-03	0.71	2.5E-07	0.54	1.9E-07	1.8E+00
Barium	7.2E-02	1.0E-03	0.71	5.1E-08	0.54	3.9E-08	3.7E-01
Cadmium (water)	3.7E-05	1.0E-03	0.71	2.6E-11	0.54	2.0E-11	1.9E-04
Copper	5.0E-02	1.0E-03	0.71	3.6E-08	0.54	2.7E-08	2.6E-01
Iron	3.2E-01	1.0E-03	0.71	2.3E-07	0.54	1.7E-07	1.6E+00
Lead	1.2E-01	1.0E-04	0.71	8.4E-09	0.54	6.4E-09	6.1E-02
Manganese (non-diet)	1.2E-01	1.0E-03	0.71	8.6E-08	0.54	6.5E-08	6.2E-01
Nickel	1.8E-03	2.0E-04	0.71	2.6E-10	0.54	1.9E-10	1.9E-03
Vanadium	4.0E-04	1.0E-03	0.71	2.8E-10	0.54	2.2E-10	2.1E-03
Zinc	4.6E-02	6.0E-04	0.71	1.9E-08	0.54	1.5E-08	1.4E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.29.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Sweat Lodge

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	4
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	3.6E-01	1.0E-03	1.0	3.6E-07	1.0	3.6E-07	2.6E+00
Barium	7.2E-02	1.0E-03	1.0	7.2E-08	1.0	7.2E-08	5.2E-01
Cadmium (water)	3.7E-05	1.0E-03	1.0	3.7E-11	1.0	3.7E-11	2.6E-04
Copper	5.0E-02	1.0E-03	1.0	5.0E-08	1.0	5.0E-08	3.6E-01
Iron	3.2E-01	1.0E-03	1.0	3.2E-07	1.0	3.2E-07	2.3E+00
Lead	1.2E-01	1.0E-04	1.0	1.2E-08	1.0	1.2E-08	8.5E-02
Manganese (non-diet)	1.2E-01	1.0E-03	1.0	1.2E-07	1.0	1.2E-07	8.7E-01
Nickel	1.8E-03	2.0E-04	1.0	3.6E-10	1.0	3.6E-10	2.6E-03
Vanadium	4.0E-04	1.0E-03	1.0	4.0E-10	1.0	4.0E-10	2.9E-03
Zinc	4.6E-02	6.0E-04	1.0	2.7E-08	1.0	2.7E-08	2.0E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	1.0E+00	mg/kg/day	3.1E-01
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	4.0E-04	mg/kg/day	2.1E-01
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.1E-01
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	3.0E-03	mg/kg/day	2.0E-01	mg/kg/day	1.5E-02
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	2.0E-03	mg/kg/day	9.2E-03
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	1.0E-03	mg/kg/day	3.2E-01
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	7.6E-04	mg/kg/day	1.5E+00	mg/kg/day	5.0E-04
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	3.0E-04	mg/kg/day	7.3E-01
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-04	mg/kg/day	4.0E-02	mg/kg/day	6.1E-03
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	3.8E-01	mg/kg/day	7.0E-01	mg/kg/day	5.4E-01
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	3.8E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	5.9E-02	mg/kg/day	2.4E-02	mg/kg/day	2.4E+00
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	3.0E-04	mg/kg/day	1.1E-01
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	2.0E-02	mg/kg/day	1.7E-02
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	8.6E-05	mg/kg/day	5.0E-03	mg/kg/day	1.7E-02
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	5.0E-03	mg/kg/day	5.4E-03
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	6.7E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					5.2E+00

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-06	mg/kg/day	3.0E-04	mg/kg/day	1.7E-02
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	2.5E-05	mg/kg/day	2.1E-02
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					3.7E-02
		Exposure Point Total									NA					5.3E+00
	Exposure Medium Total										NA					5.3E+00
Medium Total											NA					5.3E+00

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	2.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	5.0E-04	mg/kg/day	2.2E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	4.0E-02	mg/kg/day	3.9E-02
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	9.8E-03	mg/kg/day	7.0E-01	mg/kg/day	1.4E-02
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	2.4E-02	mg/kg/day	1.6E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.5E-05	mg/kg/day	2.0E-02	mg/kg/day	2.8E-03
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.5E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	3.0E-01	mg/kg/day	4.7E-03
			Exp. Route Total								NA					2.4E-01
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	1.0E+00	mg/kg/day	5.8E-04
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.4E-02	mg/kg/day	8.4E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	6.0E-08	mg/kg/day	2.5E-05	mg/kg/day	2.4E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	8.2E-05	mg/kg/day	4.0E-02	mg/kg/day	2.0E-03
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	5.2E-04	mg/kg/day	7.0E-01	mg/kg/day	7.4E-04
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	9.6E-04	mg/kg/day	2.1E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.9E-07	mg/kg/day	8.0E-04	mg/kg/day	7.3E-04
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	6.5E-07	mg/kg/day	1.3E-04	mg/kg/day	5.0E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	3.0E-01	mg/kg/day	1.5E-04
			Exp. Route Total								NA					2.3E-01
		Exposure Point Total									NA					4.7E-01

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.9E-02	mg/kg/day	1.0E+00	mg/kg/day	1.9E-02
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	3.8E-03	mg/kg/day	2.0E-01	mg/kg/day	1.9E-02
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.9E-06	mg/kg/day	5.0E-04	mg/kg/day	3.8E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	4.0E-02	mg/kg/day	6.5E-02
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	1.7E-02	mg/kg/day	7.0E-01	mg/kg/day	2.4E-02
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	6.1E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	6.3E-03	mg/kg/day	2.4E-02	mg/kg/day	2.6E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	9.4E-05	mg/kg/day	2.0E-02	mg/kg/day	4.7E-03
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	5.0E-03	mg/kg/day	4.2E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	3.0E-01	mg/kg/day	7.9E-03
			Exp. Route Total								NA					4.1E-01
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	8.2E-05	mg/kg/day	1.0E+00	mg/kg/day	8.2E-05
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	1.4E-02	mg/kg/day	1.2E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	8.4E-09	mg/kg/day	2.5E-05	mg/kg/day	3.3E-04
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	4.0E-02	mg/kg/day	2.9E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	7.0E-01	mg/kg/day	1.0E-04
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	9.6E-04	mg/kg/day	2.9E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	8.2E-08	mg/kg/day	8.0E-04	mg/kg/day	1.0E-04
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	9.2E-08	mg/kg/day	1.3E-04	mg/kg/day	7.1E-04
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	6.3E-06	mg/kg/day	3.0E-01	mg/kg/day	2.1E-05
			Exp. Route Total								NA					3.2E-02
		Exposure Point Total									NA					4.4E-01

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	2.4E-02	mg/kg/day	1.0E+00	mg/kg/day	2.4E-02
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	2.0E-01	mg/kg/day	2.4E-02
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	5.0E-04	mg/kg/day	4.9E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	4.0E-02	mg/kg/day	8.4E-02
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	2.1E-02	mg/kg/day	7.0E-01	mg/kg/day	3.0E-02
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	7.9E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	8.1E-03	mg/kg/day	2.4E-02	mg/kg/day	3.4E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	6.0E-03
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	5.0E-03	mg/kg/day	5.3E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	3.0E-03	mg/kg/day	3.0E-01	mg/kg/day	1.0E-02
			Exp. Route Total								NA					5.2E-01
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	1.0E+00	mg/kg/day	1.5E-04
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.4E-02	mg/kg/day	2.2E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	2.5E-05	mg/kg/day	6.2E-04
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	4.0E-02	mg/kg/day	5.3E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	7.0E-01	mg/kg/day	1.9E-04
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	5.0E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	5.1E-05	mg/kg/day	9.6E-04	mg/kg/day	5.3E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	8.0E-04	mg/kg/day	1.9E-04
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	1.3E-04	mg/kg/day	1.3E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	3.0E-01	mg/kg/day	3.9E-05
			Exp. Route Total								NA					5.9E-02
		Exposure Point Total									NA					5.8E-01

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	5.9E-02	mg/m^3	NA	NA	NA	NA	NA	2.5E-03	mg/m^3	5.0E-03	mg/m3	4.9E-01
				Barium	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	5.0E-04	mg/m^3	5.0E-04	mg/m3	1.0E+00
				Cadmium (water)	6.1E-06	mg/m^3	NA	NA	NA	NA	NA	2.5E-07	mg/m^3	1.0E-05	mg/m3	2.5E-02
				Copper	8.3E-03	mg/m^3	NA	NA	NA	NA	NA	3.5E-04	mg/m^3	NA	NA	NA
				Iron	5.3E-02	mg/m^3	NA	NA	NA	NA	NA	2.2E-03	mg/m^3	NA	NA	NA
				Lead	2.0E-02	mg/m^3	NA	NA	NA	NA	NA	8.2E-04	mg/m^3	NA	NA	NA
				Manganese (non-diet)	2.0E-02	mg/m^3	NA	NA	NA	NA	NA	8.4E-04	mg/m^3	5.0E-05	mg/m3	1.7E+01
				Nickel	3.0E-04	mg/m^3	NA	NA	NA	NA	NA	1.2E-05	mg/m^3	9.0E-05	mg/m3	1.4E-01
				Vanadium	6.6E-05	mg/m^3	NA	NA	NA	NA	NA	2.8E-06	mg/m^3	1.0E-04	mg/m3	2.8E-02
				Zinc	7.6E-03	mg/m^3	NA	NA	NA	NA	NA	3.2E-04	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					1.8E+01
		Exposure Point Total									NA					1.8E+01
	Exposure Medium Total										NA					2.0E+01
Medium Total											NA					2.0E+01

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	1.0E+00	mg/kg/day	1.5E-02
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	9.5E-05	mg/kg/day	3.0E-04	mg/kg/day	3.2E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-01	mg/kg/day	3.7E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	2.0E-03	mg/kg/day	1.6E-02
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-03	mg/kg/day	2.0E-01
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.5E+00	mg/kg/day	9.1E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.7E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-02	mg/kg/day	4.2E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-02	mg/kg/day	7.0E-01	mg/kg/day	4.6E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	1.4E-01	mg/kg/day	1.8E-01
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E-04	mg/kg/day	1.2E+00
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	5.0E-03	mg/kg/day	4.9E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	7.9E-04	mg/kg/day	5.0E-03	mg/kg/day	1.6E-01
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	5.0E-03	mg/kg/day	1.1E-01
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	8.9E-02	mg/kg/day	3.0E-01	mg/kg/day	3.0E-01
			Exp. Route Total								NA					5.4E+00
		Exposure Point Total									NA					5.4E+00

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-01	mg/kg/day	1.0E+00	mg/kg/day	1.4E-01
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	3.0E-04	mg/kg/day	1.9E+00
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	2.0E-01	mg/kg/day	5.1E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	2.0E-03	mg/kg/day	1.9E-01
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	6.4E-04	mg/kg/day	1.0E-03	mg/kg/day	6.4E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	1.5E+00	mg/kg/day	3.6E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	3.0E-04	mg/kg/day	2.3E-01
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	4.0E-02	mg/kg/day	7.8E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-01	mg/kg/day	7.0E-01	mg/kg/day	2.4E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+00	mg/kg/day	1.4E-01	mg/kg/day	8.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.0E-04	mg/kg/day	1.2E-01
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.9E-02
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	5.0E-03	mg/kg/day	1.7E+00
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	5.0E-03	mg/kg/day	1.4E-01
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	3.0E-01	mg/kg/day	1.5E+00
			Exp. Route Total								NA					1.6E+01
		Exposure Point Total									NA					1.6E+01

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	1.0E+00	mg/kg/day	3.4E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.0E-03	mg/kg/day	8.0E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	1.0E-03	mg/kg/day	4.8E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	1.5E+00	mg/kg/day	2.4E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.2E-02
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	7.0E-01	mg/kg/day	9.4E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	1.4E-01	mg/kg/day	2.3E-02
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E-04	mg/kg/day	1.4E-01
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	2.0E-02	mg/kg/day	5.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	6.6E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	3.0E-01	mg/kg/day	7.2E-02
			Exp. Route Total								NA					6.5E-01
		Exposure Point Total									NA					6.5E-01

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	3.0E-04	mg/kg/day	3.0E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	2.0E-01	mg/kg/day	1.2E-03
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	9.2E-05	mg/kg/day	2.0E-03	mg/kg/day	4.6E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-03	mg/kg/day	1.1E-01
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	1.5E+00	mg/kg/day	4.9E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	4.0E-02	mg/kg/day	8.4E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.8E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.8E-04	mg/kg/day	1.4E-01	mg/kg/day	5.6E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.0E-04	mg/kg/day	1.3E+00
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	8.5E-04	mg/kg/day	2.0E-02	mg/kg/day	4.3E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	3.0E-01	mg/kg/day	3.5E-01
			Exp. Route Total								NA					4.6E+00
		Exposure Point Total									NA					4.6E+00
	Exposure Medium Total										NA					2.7E+01

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	1.7E+00	mg/kg/day	1.0E+00	mg/kg/day	1.7E+00
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-04	mg/kg/day	4.2E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	6.8E-04	mg/kg/day	3.0E-04	mg/kg/day	2.3E+00
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	9.2E-02	mg/kg/day	2.0E-01	mg/kg/day	4.6E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	2.0E-03	mg/kg/day	9.2E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	6.6E-02	mg/kg/day	1.0E-03	mg/kg/day	6.6E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	1.5E+00	mg/kg/day	7.8E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-02	mg/kg/day	3.0E-04	mg/kg/day	5.5E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-02	mg/kg/day	4.0E-02	mg/kg/day	2.1E+00
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+01	mg/kg/day	7.0E-01	mg/kg/day	3.9E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	1.3E+00	mg/kg/day	1.4E-01	mg/kg/day	9.5E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-04	mg/kg/day	2.0E+00
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-02	mg/kg/day	3.8E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	5.0E-03	mg/kg/day	2.2E+00
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	6.4E+00	mg/kg/day	3.0E-01	mg/kg/day	2.1E+01
			Exp. Route Total								NA					2.1E+02
		Exposure Point Total									NA					2.1E+02

TABLE 7.30.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	2.5E-05	mg/kg/day	9.5E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.1E-02
		Exposure Point Total									NA					1.1E-02
	Exposure Medium Total										NA					2.1E+02
Medium Total											NA					2.3E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					3E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	8.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+00	mg/kg	1.8E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.7E-05	NA	NA	NA	NA	NA
				Barium	1.3E+02	mg/kg	8.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	8.0E-01	mg/kg	5.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.4E+01	mg/kg	9.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	2.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	9.6E+00	mg/kg	6.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.1E+01	mg/kg	6.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+04	mg/kg	1.1E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.7E+02	mg/kg	1.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.4E+00	mg/kg	9.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E+01	mg/kg	9.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	3.8E+00	mg/kg	2.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.2E+00	mg/kg	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.0E+00	mg/kg	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.0E+03	mg/kg	1.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.7E-05					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+00	mg/kg	3.5E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.2E-06	NA	NA	NA	NA	NA
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.4E+01	mg/kg	3.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								5.2E-06					NA
		Exposure Point Total									3.2E-05					NA
	Exposure Medium Total										3.2E-05					NA
Medium Total											3.2E-05					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	3.6E-01	mg/L	3.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	6.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	3.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	4.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	2.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	1.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	1.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	3.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	4.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								0.0E+00					NA
			Dermal	Aluminum	3.6E-01	mg/L	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	5.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	7.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	4.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	1.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	5.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	5.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	4.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								0.0E+00					NA
		Exposure Point Total									0.0E+00					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	3.6E-01	mg/L	1.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	2.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	1.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	1.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	4.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	4.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	6.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	1.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								0.0E+00					NA
			Dermal	Aluminum	3.6E-01	mg/L	7.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	7.4E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	2.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	2.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	7.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	8.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	5.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								0.0E+00					NA
		Exposure Point Total									0.0E+00					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	3.6E-01	mg/L	6.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	6.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	8.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	5.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	2.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	2.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	6.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	7.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								0.0E+00					NA
			Dermal	Aluminum	3.6E-01	mg/L	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	2.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	1.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	1.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	8.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	3.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	3.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	1.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	7.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								0.0E+00					NA
		Exposure Point Total									0.0E+00					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	5.9E-02	mg/m^3	2.4E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	1.2E-02	mg/m^3	4.8E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	6.1E-06	mg/m^3	2.5E-07	mg/m^3	1.8E-03	1/(µg/m3)	4.4E-07	NA	NA	NA	NA	NA
				Copper	8.3E-03	mg/m^3	3.4E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.3E-02	mg/m^3	2.1E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	2.0E-02	mg/m^3	7.9E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.0E-02	mg/m^3	8.1E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.0E-04	mg/m^3	1.2E-05	mg/m^3	2.6E-04	1/(µg/m3)	3.1E-06	NA	NA	NA	NA	NA
				Vanadium	6.6E-05	mg/m^3	2.7E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	7.6E-03	mg/m^3	3.1E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.6E-06					NA
		Exposure Point Total									3.6E-06					NA
	Exposure Medium Total										3.6E-06					NA
Medium Total											3.6E-06					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	7.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.2E-02	mg/kg	4.5E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-05	NA	NA	NA	NA	NA
				Barium	2.5E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E-02	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.6E-02	mg/kg	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	6.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	4.7E-02	mg/kg	6.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.6E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.1E+01	mg/kg	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.6E-01	mg/kg	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.1E-02	mg/kg	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.2E-02	mg/kg	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-01	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.6E-01	mg/kg	3.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.9E-01	mg/kg	5.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.0E+01	mg/kg	4.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.8E-05					NA
		Exposure Point Total									6.8E-05					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	6.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.8E-01	mg/kg	2.8E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.1E-04	NA	NA	NA	NA	NA
				Barium	1.0E+02	mg/kg	4.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.4E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.4E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.8E-02	mg/kg	3.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	3.1E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+02	mg/kg	8.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.9E+00	mg/kg	9.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	5.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.2E-02	mg/kg	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.9E-01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.7E+00	mg/kg	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.3E+02	mg/kg	3.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	7.2E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+02	mg/kg	2.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.1E-04					NA
		Exposure Point Total									4.1E-04					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.5E-02	mg/kg	2.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.2E-05	NA	NA	NA	NA	NA
				Barium	4.5E+00	mg/kg	1.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E-02	mg/kg	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	5.9E-02	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.8E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	8.2E+00	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.7E-02	mg/kg	6.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.3E-01	mg/kg	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.3E-01	mg/kg	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.0E-01	mg/kg	7.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	5.7E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.7E+01	mg/kg	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.2E-05					NA
		Exposure Point Total									3.2E-05					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	5.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.1E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.9E-02	mg/kg	4.3E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.4E-05	NA	NA	NA	NA	NA
				Barium	1.1E-01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.0E-02	mg/kg	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	4.7E-02	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.2E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+01	mg/kg	4.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	5.1E-01	mg/kg	5.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	3.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.8E-02	mg/kg	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.7E-01	mg/kg	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	7.8E-01	mg/kg	8.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.6E-01	mg/kg	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+01	mg/kg	5.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-05					NA
		Exposure Point Total									6.4E-05					NA
	Exposure Medium Total										5.8E-04					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	8.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.5E-01	mg/kg	3.2E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-04	NA	NA	NA	NA	NA
				Barium	2.1E+01	mg/kg	4.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.1E-02	mg/kg	8.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+01	mg/kg	3.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.7E+00	mg/kg	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.7E+00	mg/kg	7.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.9E+01	mg/kg	4.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.1E+03	mg/kg	1.3E+01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	7.1E+01	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	6.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.5E-02	mg/kg	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.7E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.7E-01	mg/kg	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	5.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.4E+03	mg/kg	3.1E+00	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-04					NA
		Exposure Point Total									4.8E-04					NA

TABLE 7.31.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.1E-01	mg/kg	2.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.3E-07	NA	NA	NA	NA	NA
				Barium	2.0E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	2.1E+01	mg/kg	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.7E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.2E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.3E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.6E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.8E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.3E-07					NA
		Exposure Point Total									3.3E-07					NA
	Exposure Medium Total										4.9E-04					NA
Medium Total											1.1E-03					NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											1E-03					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.32.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	1.9E-02	mg/kg/day	NA	NA	NA	5.4E-02	mg/kg/day	1.0E+00	mg/kg/day	5.4E-02
				Antimony	3.6E+00	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	1.4E-05	mg/kg/day	4.0E-04	mg/kg/day	3.6E-02
				Arsenic	4.6E+00	mg/kg	3.9E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.8E-06	1.1E-05	mg/kg/day	3.0E-04	mg/kg/day	3.6E-02
				Barium	1.3E+02	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	5.1E-04	mg/kg/day	2.0E-01	mg/kg/day	2.5E-03
				Beryllium	8.0E-01	mg/kg	1.1E-06	mg/kg/day	NA	NA	NA	3.1E-06	mg/kg/day	2.0E-03	mg/kg/day	1.6E-03
				Cadmium (non-water)	1.4E+01	mg/kg	2.0E-05	mg/kg/day	NA	NA	NA	5.6E-05	mg/kg/day	1.0E-03	mg/kg/day	5.6E-02
				Chromium (trivalent)	3.3E+01	mg/kg	4.6E-05	mg/kg/day	NA	NA	NA	1.3E-04	mg/kg/day	1.5E+00	mg/kg/day	8.6E-05
				Cobalt	9.6E+00	mg/kg	1.3E-05	mg/kg/day	NA	NA	NA	3.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Copper	1.1E+01	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	4.2E-05	mg/kg/day	4.0E-02	mg/kg/day	1.0E-03
				Iron	1.7E+04	mg/kg	2.3E-02	mg/kg/day	NA	NA	NA	6.5E-02	mg/kg/day	7.0E-01	mg/kg/day	9.3E-02
				Lead	1.7E+02	mg/kg	2.3E-04	mg/kg/day	NA	NA	NA	6.6E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	1.0E-02	mg/kg/day	2.4E-02	mg/kg/day	4.2E-01
				Mercury (HgCl)	1.4E+00	mg/kg	2.0E-06	mg/kg/day	NA	NA	NA	5.5E-06	mg/kg/day	3.0E-04	mg/kg/day	1.8E-02
				Nickel	1.5E+01	mg/kg	2.1E-05	mg/kg/day	NA	NA	NA	5.9E-05	mg/kg/day	2.0E-02	mg/kg/day	2.9E-03
				Selenium	3.8E+00	mg/kg	5.3E-06	mg/kg/day	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	3.0E-03
				Silver	1.2E+00	mg/kg	1.6E-06	mg/kg/day	NA	NA	NA	4.6E-06	mg/kg/day	5.0E-03	mg/kg/day	9.2E-04
				Thallium	3.0E+00	mg/kg	4.1E-06	mg/kg/day	NA	NA	NA	1.2E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	4.1E-05	mg/kg/day	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-03	mg/kg/day	2.3E-02
				Zinc	2.0E+03	mg/kg	2.7E-03	mg/kg/day	NA	NA	NA	7.7E-03	mg/kg/day	3.0E-01	mg/kg/day	2.6E-02
			Exp. Route Total								5.8E-06					9.0E-01

TABLE 7.32.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+00	mg/kg	9.5E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.2E-06	2.7E-06	mg/kg/day	3.0E-04	mg/kg/day	8.9E-03
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.4E+01	mg/kg	9.8E-08	mg/kg/day	NA	NA	NA	2.7E-07	mg/kg/day	2.5E-05	mg/kg/day	1.1E-02
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								5.2E-06					2.0E-02
		Exposure Point Total									1.1E-05					9.2E-01
	Exposure Medium Total										1.1E-05					9.2E-01
Medium Total											1.1E-05					9.2E-01

TABLE 7.32.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Ingestion	Aluminum	3.6E-01	mg/L	6.9E-04	mg/kg/day	NA	NA	NA	1.9E-03	mg/kg/day	1.0E+00	mg/kg/day	1.9E-03
				Barium	7.2E-02	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	3.9E-04	mg/kg/day	2.0E-01	mg/kg/day	1.9E-03
				Cadmium (water)	3.7E-05	mg/L	7.0E-08	mg/kg/day	NA	NA	NA	2.0E-07	mg/kg/day	5.0E-04	mg/kg/day	3.9E-04
				Copper	5.0E-02	mg/L	9.7E-05	mg/kg/day	NA	NA	NA	2.7E-04	mg/kg/day	4.0E-02	mg/kg/day	6.8E-03
				Iron	3.2E-01	mg/L	6.1E-04	mg/kg/day	NA	NA	NA	1.7E-03	mg/kg/day	7.0E-01	mg/kg/day	2.5E-03
				Lead	1.2E-01	mg/L	2.3E-04	mg/kg/day	NA	NA	NA	6.4E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	2.3E-04	mg/kg/day	NA	NA	NA	6.5E-04	mg/kg/day	2.4E-02	mg/kg/day	2.7E-02
				Nickel	1.8E-03	mg/L	3.5E-06	mg/kg/day	NA	NA	NA	9.7E-06	mg/kg/day	2.0E-02	mg/kg/day	4.9E-04
				Vanadium	4.0E-04	mg/L	7.7E-07	mg/kg/day	NA	NA	NA	2.2E-06	mg/kg/day	5.0E-03	mg/kg/day	4.3E-04
				Zinc	4.6E-02	mg/L	8.8E-05	mg/kg/day	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-01	mg/kg/day	8.2E-04
			Exp. Route Total								0.0E+00					4.2E-02
			Dermal	Aluminum	3.6E-01	mg/L	1.5E-04	mg/kg/day	NA	NA	NA	4.1E-04	mg/kg/day	1.0E+00	mg/kg/day	4.1E-04
				Barium	7.2E-02	mg/L	3.0E-05	mg/kg/day	NA	NA	NA	8.3E-05	mg/kg/day	1.4E-02	mg/kg/day	5.9E-03
				Cadmium (water)	3.7E-05	mg/L	1.5E-08	mg/kg/day	NA	NA	NA	4.2E-08	mg/kg/day	2.5E-05	mg/kg/day	1.7E-03
				Copper	5.0E-02	mg/L	2.1E-05	mg/kg/day	NA	NA	NA	5.8E-05	mg/kg/day	4.0E-02	mg/kg/day	1.4E-03
				Iron	3.2E-01	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	3.7E-04	mg/kg/day	7.0E-01	mg/kg/day	5.2E-04
				Lead	1.2E-01	mg/L	4.9E-06	mg/kg/day	NA	NA	NA	1.4E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	5.0E-05	mg/kg/day	NA	NA	NA	1.4E-04	mg/kg/day	9.6E-04	mg/kg/day	1.5E-01
				Nickel	1.8E-03	mg/L	1.5E-07	mg/kg/day	NA	NA	NA	4.2E-07	mg/kg/day	8.0E-04	mg/kg/day	5.2E-04
				Vanadium	4.0E-04	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	4.6E-07	mg/kg/day	1.3E-04	mg/kg/day	3.5E-03
				Zinc	4.6E-02	mg/L	1.1E-05	mg/kg/day	NA	NA	NA	3.2E-05	mg/kg/day	3.0E-01	mg/kg/day	1.1E-04
			Exp. Route Total								0.0E+00					1.6E-01
		Exposure Point Total									0.0E+00					2.0E-01
	Exposure Medium Total										0.0E+00					2.0E-01
Medium Total											0.0E+00					2.0E-01
Receptor Total (Sediment + Surface Water)											1E-05					1E+00

Notes:

CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.32.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Exposure Scenario: Work Activities

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)
Aluminum	3.6E-01	1.0E-03	6.0	2.1E-06
Barium	7.2E-02	1.0E-03	6.0	4.3E-07
Cadmium (water)	3.7E-05	1.0E-03	6.0	2.2E-10
Copper	5.0E-02	1.0E-03	6.0	3.0E-07
Iron	3.2E-01	1.0E-03	6.0	1.9E-06
Lead	1.2E-01	1.0E-04	6.0	7.1E-08
Manganese (non-diet)	1.2E-01	1.0E-03	6.0	7.3E-07
Nickel	1.8E-03	2.0E-04	6.0	2.2E-09
Vanadium	4.0E-04	1.0E-03	6.0	2.4E-09
Zinc	4.6E-02	6.0E-04	6.0	1.6E-07

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event =milligram per square centimeter per event
mg/L = milligram per liter

TABLE 7.33.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	1.0E+00	mg/kg/day	1.3E-03
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	3.5E-07	mg/kg/day	4.0E-04	mg/kg/day	8.7E-04
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	2.7E-07	mg/kg/day	3.0E-04	mg/kg/day	8.8E-04
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	2.0E-01	mg/kg/day	6.2E-05
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	7.7E-08	mg/kg/day	2.0E-03	mg/kg/day	3.9E-05
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	1.0E-03	mg/kg/day	1.4E-03
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	1.5E+00	mg/kg/day	2.1E-06
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	9.2E-07	mg/kg/day	3.0E-04	mg/kg/day	3.1E-03
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	4.0E-02	mg/kg/day	2.6E-05
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	7.0E-01	mg/kg/day	2.3E-03
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	2.4E-02	mg/kg/day	1.0E-02
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	3.0E-04	mg/kg/day	4.5E-04
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	2.0E-02	mg/kg/day	7.2E-05
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.6E-07	mg/kg/day	5.0E-03	mg/kg/day	7.2E-05
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	5.0E-03	mg/kg/day	2.3E-05
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	5.0E-03	mg/kg/day	5.6E-04
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	3.0E-01	mg/kg/day	6.3E-04
			Exp. Route Total								NA					2.2E-02

TABLE 7.33.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	5.6E-08	mg/kg/day	3.0E-04	mg/kg/day	1.9E-04
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	5.8E-09	mg/kg/day	2.5E-05	mg/kg/day	2.3E-04
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					4.2E-04
		Exposure Point Total									NA					2.2E-02
	Exposure Medium Total										NA					2.2E-02
Medium Total											NA					2.2E-02

TABLE 7.33.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	1.0E+00	mg/kg/day	3.2E-05
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	6.4E-06	mg/kg/day	2.0E-01	mg/kg/day	3.2E-05
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	3.2E-09	mg/kg/day	5.0E-04	mg/kg/day	6.4E-06
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	4.4E-06	mg/kg/day	4.0E-02	mg/kg/day	1.1E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	7.0E-01	mg/kg/day	4.0E-05
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	2.4E-02	mg/kg/day	4.4E-04
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	2.0E-02	mg/kg/day	7.9E-06
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	3.5E-08	mg/kg/day	5.0E-03	mg/kg/day	7.1E-06
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	4.0E-06	mg/kg/day	3.0E-01	mg/kg/day	1.3E-05
			Exp. Route Total								NA					6.9E-04
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	6.7E-06	mg/kg/day	1.0E+00	mg/kg/day	6.7E-06
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	1.4E-02	mg/kg/day	9.7E-05
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	6.9E-10	mg/kg/day	2.5E-05	mg/kg/day	2.8E-05
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	9.4E-07	mg/kg/day	4.0E-02	mg/kg/day	2.4E-05
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	6.0E-06	mg/kg/day	7.0E-01	mg/kg/day	8.6E-06
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	9.6E-04	mg/kg/day	2.4E-03
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	6.8E-09	mg/kg/day	8.0E-04	mg/kg/day	8.5E-06
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	7.5E-09	mg/kg/day	1.3E-04	mg/kg/day	5.8E-05
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	5.2E-07	mg/kg/day	3.0E-01	mg/kg/day	1.7E-06
			Exp. Route Total								NA					2.6E-03
		Exposure Point Total									NA					3.3E-03

TABLE 7.33.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	4.1E-06	mg/kg/day	1.0E+00	mg/kg/day	4.1E-06
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	8.4E-07	mg/kg/day	1.4E-02	mg/kg/day	6.0E-05
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	4.2E-10	mg/kg/day	2.5E-05	mg/kg/day	1.7E-05
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	5.8E-07	mg/kg/day	4.0E-02	mg/kg/day	1.4E-05
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	3.7E-06	mg/kg/day	7.0E-01	mg/kg/day	5.3E-06
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	9.6E-04	mg/kg/day	1.5E-03
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	4.2E-09	mg/kg/day	8.0E-04	mg/kg/day	5.2E-06
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	4.6E-09	mg/kg/day	1.3E-04	mg/kg/day	3.6E-05
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	3.2E-07	mg/kg/day	3.0E-01	mg/kg/day	1.1E-06
			Exp. Route Total								NA					1.6E-03
		Exposure Point Total									NA					1.6E-03
		Surface Water (Potable Use)	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	2.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.1E-02
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	5.0E-04	mg/kg/day	2.2E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	4.0E-02	mg/kg/day	3.8E-02
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	9.5E-03	mg/kg/day	7.0E-01	mg/kg/day	1.4E-02
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.5E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.4E-02	mg/kg/day	1.5E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	5.4E-05	mg/kg/day	2.0E-02	mg/kg/day	2.7E-03
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.4E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	3.0E-01	mg/kg/day	4.6E-03
			Exp. Route Total								NA					2.4E-01

TABLE 7.33.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	1.0E+00	mg/kg/day	6.0E-05
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.4E-02	mg/kg/day	8.6E-04
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	6.1E-09	mg/kg/day	2.5E-05	mg/kg/day	2.4E-04
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	8.4E-06	mg/kg/day	4.0E-02	mg/kg/day	2.1E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	7.0E-01	mg/kg/day	7.6E-05
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.0E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	9.6E-04	mg/kg/day	2.1E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	6.0E-08	mg/kg/day	8.0E-04	mg/kg/day	7.5E-05
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	6.7E-08	mg/kg/day	1.3E-04	mg/kg/day	5.1E-04
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	4.6E-06	mg/kg/day	3.0E-01	mg/kg/day	1.5E-05
			Exp. Route Total								NA					2.3E-02
		Exposure Point Total									NA					2.6E-01
	Exposure Medium Total (Swimming + Potable Use)										NA					2.6E-01
	Exposure Medium Total (Wading + Potable Use)										NA					2.6E-01
Medium Total (Swimming + Potable Use)											NA					2.6E-01
Medium Total (Wading + Potable Use)											NA					2.6E-01

TABLE 7.33.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-04	mg/kg/day	5.1E-01
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.1E-02
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	9.9E-06	mg/kg/day	2.0E-03	mg/kg/day	4.9E-03
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.0E-03	mg/kg/day	3.1E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	1.9E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	7.0E-01	mg/kg/day	4.5E-03
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	1.4E-01	mg/kg/day	1.2E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	1.0E-04	mg/kg/day	4.2E-01
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.6E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	3.0E-01	mg/kg/day	2.9E-02
			Exp. Route Total								NA					1.5E+00
		Exposure Point Total									NA					1.5E+00
	Exposure Medium Total										NA					1.5E+00
Medium Total											NA					1.5E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					2E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					2E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.33.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	3.6E-01	1.0E-03	1.0	3.6E-07	1.0	3.6E-07	7.5E-02
Barium	7.2E-02	1.0E-03	1.0	7.2E-08	1.0	7.2E-08	1.5E-02
Cadmium (water)	3.7E-05	1.0E-03	1.0	3.7E-11	1.0	3.7E-11	7.6E-06
Copper	5.0E-02	1.0E-03	1.0	5.0E-08	1.0	5.0E-08	1.0E-02
Iron	3.2E-01	1.0E-03	1.0	3.2E-07	1.0	3.2E-07	6.6E-02
Lead	1.2E-01	1.0E-04	1.0	1.2E-08	1.0	1.2E-08	2.5E-03
Manganese (non-diet)	1.2E-01	1.0E-03	1.0	1.2E-07	1.0	1.2E-07	2.5E-02
Nickel	1.8E-03	2.0E-04	1.0	3.6E-10	1.0	3.6E-10	7.5E-05
Vanadium	4.0E-04	1.0E-03	1.0	4.0E-10	1.0	4.0E-10	8.4E-05
Zinc	4.6E-02	6.0E-04	1.0	2.7E-08	1.0	2.7E-08	5.7E-03

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.33.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Wading

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	6,032	2,373
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	3.6E-01	1.0E-03	2.0	7.2E-07	2.0	7.2E-07	4.9E-02
Barium	7.2E-02	1.0E-03	2.0	1.4E-07	2.0	1.4E-07	9.9E-03
Cadmium (water)	3.7E-05	1.0E-03	2.0	7.3E-11	2.0	7.3E-11	5.0E-06
Copper	5.0E-02	1.0E-03	2.0	1.0E-07	2.0	1.0E-07	6.9E-03
Iron	3.2E-01	1.0E-03	2.0	6.4E-07	2.0	6.4E-07	4.4E-02
Lead	1.2E-01	1.0E-04	2.0	2.4E-08	2.0	2.4E-08	1.6E-03
Manganese (non-diet)	1.2E-01	1.0E-03	2.0	2.4E-07	2.0	2.4E-07	1.7E-02
Nickel	1.8E-03	2.0E-04	2.0	7.2E-10	2.0	7.2E-10	5.0E-05
Vanadium	4.0E-04	1.0E-03	2.0	8.0E-10	2.0	8.0E-10	5.5E-05
Zinc	4.6E-02	6.0E-04	2.0	5.5E-08	2.0	5.5E-08	3.8E-03

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.33.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	350	350
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	3.6E-01	1.0E-03	0.71	2.5E-07	0.54	1.9E-07	6.1E-01
Barium	7.2E-02	1.0E-03	0.71	5.1E-08	0.54	3.9E-08	1.2E-01
Cadmium (water)	3.7E-05	1.0E-03	0.71	2.6E-11	0.54	2.0E-11	6.2E-05
Copper	5.0E-02	1.0E-03	0.71	3.6E-08	0.54	2.7E-08	8.5E-02
Iron	3.2E-01	1.0E-03	0.71	2.3E-07	0.54	1.7E-07	5.4E-01
Lead	1.2E-01	1.0E-04	0.71	8.4E-09	0.54	6.4E-09	2.0E-02
Manganese (non-diet)	1.2E-01	1.0E-03	0.71	8.6E-08	0.54	6.5E-08	2.1E-01
Nickel	1.8E-03	2.0E-04	0.71	2.6E-10	0.54	1.9E-10	6.1E-04
Vanadium	4.0E-04	1.0E-03	0.71	2.8E-10	0.54	2.2E-10	6.8E-04
Zinc	4.6E-02	6.0E-04	0.71	1.9E-08	0.54	1.5E-08	4.7E-02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
mg/L = milligram per liter
mg/kg = milligram per kilogram

TABLE 7.34.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	1.0E+00	mg/kg/day	1.4E-02
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-06	mg/kg/day	4.0E-04	mg/kg/day	9.3E-03
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	3.0E-04	mg/kg/day	9.4E-03
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	2.0E-01	mg/kg/day	6.6E-04
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	8.2E-07	mg/kg/day	2.0E-03	mg/kg/day	4.1E-04
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	1.0E-03	mg/kg/day	1.5E-02
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	1.5E+00	mg/kg/day	2.3E-05
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	9.9E-06	mg/kg/day	3.0E-04	mg/kg/day	3.3E-02
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	4.0E-02	mg/kg/day	2.7E-04
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	1.7E-02	mg/kg/day	7.0E-01	mg/kg/day	2.4E-02
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	2.4E-02	mg/kg/day	1.1E-01
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	3.0E-04	mg/kg/day	4.8E-03
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	2.0E-02	mg/kg/day	7.7E-04
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	5.0E-03	mg/kg/day	7.7E-04
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	5.0E-03	mg/kg/day	2.4E-04
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	3.0E-06	mg/kg/day	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	5.0E-03	mg/kg/day	6.0E-03
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	3.0E-01	mg/kg/day	6.7E-03
			Exp. Route Total								NA					2.3E-01

TABLE 7.34.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	4.6E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	3.0E-04	mg/kg/day	1.1E-03
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	1.4E+01	mg/kg	NA	NA	NA	NA	NA	3.5E-08	mg/kg/day	2.5E-05	mg/kg/day	1.4E-03
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					2.5E-03
		Exposure Point Total									NA					2.4E-01
	Exposure Medium Total										NA					2.4E-01
Medium Total											NA					2.4E-01

TABLE 7.34.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	1.0E+00	mg/kg/day	2.2E-04
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	2.0E-01	mg/kg/day	2.2E-04
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	2.2E-08	mg/kg/day	5.0E-04	mg/kg/day	4.5E-05
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	4.0E-02	mg/kg/day	7.7E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	7.0E-01	mg/kg/day	2.8E-04
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	7.2E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	7.4E-05	mg/kg/day	2.4E-02	mg/kg/day	3.1E-03
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	2.0E-02	mg/kg/day	5.5E-05
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	2.5E-07	mg/kg/day	5.0E-03	mg/kg/day	4.9E-05
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	3.0E-01	mg/kg/day	9.3E-05
			Exp. Route Total								NA					4.8E-03
			Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.0E+00	mg/kg/day	1.2E-05
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	1.4E-02	mg/kg/day	1.7E-04
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.2E-09	mg/kg/day	2.5E-05	mg/kg/day	4.8E-05
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg/day	4.0E-02	mg/kg/day	4.1E-05
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	7.0E-01	mg/kg/day	1.5E-05
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.8E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	9.6E-04	mg/kg/day	4.1E-03
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	1.2E-08	mg/kg/day	8.0E-04	mg/kg/day	1.5E-05
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	1.3E-08	mg/kg/day	1.3E-04	mg/kg/day	1.0E-04
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	8.9E-07	mg/kg/day	3.0E-01	mg/kg/day	3.0E-06
			Exp. Route Total								NA					4.5E-03
		Exposure Point Total									NA					9.3E-03

TABLE 7.34.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	8.7E-06	mg/kg/day	1.0E+00	mg/kg/day	8.7E-06
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	1.4E-02	mg/kg/day	1.3E-04
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	8.9E-10	mg/kg/day	2.5E-05	mg/kg/day	3.5E-05
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	4.0E-02	mg/kg/day	3.0E-05
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	7.7E-06	mg/kg/day	7.0E-01	mg/kg/day	1.1E-05
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.9E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.9E-06	mg/kg/day	9.6E-04	mg/kg/day	3.1E-03
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	8.7E-09	mg/kg/day	8.0E-04	mg/kg/day	1.1E-05
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	9.7E-09	mg/kg/day	1.3E-04	mg/kg/day	7.5E-05
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	6.6E-07	mg/kg/day	3.0E-01	mg/kg/day	2.2E-06
			Exp. Route Total								NA					3.4E-03
		Exposure Point Total									NA					3.4E-03
		Surface Water (Potable Use)	Ingestion	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	1.8E-02	mg/kg/day	1.0E+00	mg/kg/day	1.8E-02
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	5.0E-04	mg/kg/day	3.6E-03
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	4.0E-02	mg/kg/day	6.2E-02
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	1.6E-02	mg/kg/day	7.0E-01	mg/kg/day	2.3E-02
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	5.9E-03	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	6.0E-03	mg/kg/day	2.4E-02	mg/kg/day	2.5E-01
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	2.0E-02	mg/kg/day	4.5E-03
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	5.0E-03	mg/kg/day	4.0E-03
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	3.0E-01	mg/kg/day	7.6E-03
			Exp. Route Total								NA					3.9E-01

TABLE 7.34.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	3.6E-01	mg/L	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	1.0E+00	mg/kg/day	7.9E-05
				Barium	7.2E-02	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	1.4E-02	mg/kg/day	1.1E-03
				Cadmium (water)	3.7E-05	mg/L	NA	NA	NA	NA	NA	8.0E-09	mg/kg/day	2.5E-05	mg/kg/day	3.2E-04
				Copper	5.0E-02	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	4.0E-02	mg/kg/day	2.8E-04
				Iron	3.2E-01	mg/L	NA	NA	NA	NA	NA	7.0E-05	mg/kg/day	7.0E-01	mg/kg/day	1.0E-04
				Lead	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	9.6E-04	mg/kg/day	2.8E-02
				Nickel	1.8E-03	mg/L	NA	NA	NA	NA	NA	7.9E-08	mg/kg/day	8.0E-04	mg/kg/day	9.9E-05
				Vanadium	4.0E-04	mg/L	NA	NA	NA	NA	NA	8.8E-08	mg/kg/day	1.3E-04	mg/kg/day	6.8E-04
				Zinc	4.6E-02	mg/L	NA	NA	NA	NA	NA	6.0E-06	mg/kg/day	3.0E-01	mg/kg/day	2.0E-05
			Exp. Route Total								NA					3.0E-02
		Exposure Point Total									NA					4.2E-01
	Exposure Medium Total (Swimming + Potable Use)										NA					4.3E-01
	Exposure Medium Total (Wading + Potable Use)										NA					4.3E-01
Medium Total (Swimming + Potable Use)											NA					4.3E-01
Medium Total (Wading + Potable Use)											NA					4.3E-01

TABLE 7.34.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	1.0E+00	mg/kg/day	3.1E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	4.0E-04	mg/kg/day	1.4E+00
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	7.4E-04	mg/kg/day	2.0E-01	mg/kg/day	3.7E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	1.0E-03	mg/kg/day	8.3E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	1.5E+00	mg/kg/day	5.0E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	4.0E-02	mg/kg/day	2.8E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	8.4E-03	mg/kg/day	7.0E-01	mg/kg/day	1.2E-02
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	1.4E-01	mg/kg/day	3.1E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-04	mg/kg/day	1.1E+00
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.4E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	5.0E-03	mg/kg/day	7.0E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	3.0E-01	mg/kg/day	7.8E-02
			Exp. Route Total								NA					3.9E+00
		Exposure Point Total									NA					3.9E+00
	Exposure Medium Total										NA					3.9E+00
Medium Total											NA					3.9E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					5E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					5E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.35.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	1.4E+04	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	4.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+00	mg/kg	3.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-07	NA	NA	NA	NA	NA
				Barium	1.3E+02	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	8.0E-01	mg/kg	9.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.4E+01	mg/kg	1.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	3.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	9.6E+00	mg/kg	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.1E+01	mg/kg	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+04	mg/kg	1.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.7E+02	mg/kg	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.4E+00	mg/kg	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E+01	mg/kg	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	3.8E+00	mg/kg	4.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.2E+00	mg/kg	1.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.0E+00	mg/kg	3.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	3.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.0E+03	mg/kg	2.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-07					NA

TABLE 7.35.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	1.4E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	4.6E+00	mg/kg	4.5E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.7E-08	NA	NA	NA	NA	NA
				Barium	1.3E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.4E+01	mg/kg	4.6E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	9.6E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.1E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.4E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	3.8E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.9E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.7E-08					NA
		Exposure Point Total									5.4E-07					NA
	Exposure Medium Total										5.4E-07					NA
Medium Total											5.4E-07					NA

TABLE 7.35.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	3.6E-01	mg/L	2.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	5.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	2.8E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	3.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	2.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	9.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	9.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	1.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	3.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	3.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								NA					NA
			Dermal	Aluminum	3.6E-01	mg/L	2.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	5.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	3.0E-10	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	4.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	9.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	9.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	2.9E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	3.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	2.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								NA					NA
		Exposure Point Total									NA					NA

TABLE 7.35.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	3.6E-01	mg/L	1.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	3.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	2.0E-10	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	2.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	6.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	6.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	1.9E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	2.2E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	1.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								NA					NA
		Exposure Point Total									NA					NA
		Surface Water (Potable Use)	Ingestion	Aluminum	3.6E-01	mg/L	4.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	9.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	4.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	6.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	4.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	5.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								NA					NA

TABLE 7.35.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	3.6E-01	mg/L	2.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Barium	7.2E-02	mg/L	4.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	3.7E-05	mg/L	2.4E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-02	mg/L	3.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.2E-01	mg/L	2.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.2E-01	mg/L	7.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.2E-01	mg/L	8.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.8E-03	mg/L	2.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	4.0E-04	mg/L	2.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E-02	mg/L	1.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								NA					NA
		Exposure Point Total									NA					NA
	Exposure Medium Total (Swimming + Potable Use)										NA					NA
	Exposure Medium Total (Wading + Potable Use)										NA					NA
Medium Total (Swimming + Potable Use)											NA					NA
Medium Total (Wading + Potable Use)											NA					NA

TABLE 7.35.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lost Creek Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	5.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.3E-02	mg/kg	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	NA	NA	NA	NA	NA
				Barium	3.3E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E-02	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.7E-02	mg/kg	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.4E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.0E-02	mg/kg	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.0E-01	mg/kg	4.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	8.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.0E-02	mg/kg	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	7.6E-02	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.0E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.6E-01	mg/kg	6.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	6.9E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.0E+01	mg/kg	4.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.1E-05					NA
		Exposure Point Total									2.1E-05					NA
	Exposure Medium Total										2.1E-05					NA
Medium Total											2.1E-05					NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)											2E-05					NA
Receptor Total (Sediment + Wading + Potable Use + Fish)											2E-05					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	3.9E-02	mg/kg/day	1.0E+00	mg/kg/day	3.9E-02
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	9.5E-06	mg/kg/day	4.0E-04	mg/kg/day	2.4E-02
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.6E-01
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	2.1E-03	mg/kg/day	2.0E-01	mg/kg/day	1.0E-02
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	2.0E-03	mg/kg/day	5.0E-03
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	2.0E-01	mg/kg/day	3.0E-04
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	1.0E-03	mg/kg/day	1.9E-01
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	1.5E+00	mg/kg/day	2.0E-04
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-04	mg/kg/day	4.2E-01
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	4.0E-02	mg/kg/day	3.0E-03
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	2.4E-01	mg/kg/day	7.0E-01	mg/kg/day	3.4E-01
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	2.0E-03	mg/kg/day	1.3E-01
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	5.3E-03	mg/kg/day	2.4E-02	mg/kg/day	2.2E-01
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	8.4E-07	mg/kg/day	3.0E-04	mg/kg/day	2.8E-03
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	5.0E-03	mg/kg/day	9.8E-02
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	2.0E-02	mg/kg/day	8.9E-03
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	5.0E-03	mg/kg/day	6.1E-03
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	5.0E-03	mg/kg/day	7.8E-03
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	5.3E-04	mg/kg/day	6.0E-01	mg/kg/day	8.8E-04
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	3.9E-07	mg/kg/day	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-04	mg/kg/day	5.0E-03	mg/kg/day	8.1E-02
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	1.8E-02	mg/kg/day	3.0E-01	mg/kg/day	5.9E-02
			Exp. Route Total								NA					1.8E+00

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	3.0E-04	mg/kg/day	3.9E-02
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	NA
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	9.4E-07	mg/kg/day	2.5E-05	mg/kg/day	3.8E-02
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.7E-02
		Exposure Point Total									NA					1.9E+00
	Exposure Medium Total										NA					1.9E+00
Medium Total											NA					1.9E+00

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	1.0E+00	mg/kg/day	1.3E-02
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	6.1E-06	mg/kg/day	4.0E-04	mg/kg/day	1.5E-02
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	6.2E-06	mg/kg/day	3.0E-04	mg/kg/day	2.1E-02
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	5.3E-04	mg/kg/day	2.0E-01	mg/kg/day	2.7E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	5.0E-04	mg/kg/day	2.3E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	3.0E-03	mg/kg/day	5.2E-03
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	3.0E-04	mg/kg/day	4.5E-02
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	4.3E-05	mg/kg/day	4.0E-02	mg/kg/day	1.1E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.7E-02
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	2.4E-02	mg/kg/day	5.9E-02
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	3.5E-06	mg/kg/day	3.0E-04	mg/kg/day	1.2E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	5.0E-03	mg/kg/day	5.3E-03
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	6.4E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	3.2E-06	mg/kg/day	5.0E-03	mg/kg/day	6.4E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	5.4E-06	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	2.9E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	3.0E-01	mg/kg/day	5.7E-03
			Exp. Route Total								NA					2.3E-01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	2.7E-03	mg/kg/day	1.0E+00	mg/kg/day	2.7E-03
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	6.0E-05	mg/kg/day	2.2E-02
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	3.0E-04	mg/kg/day	4.4E-03
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.4E-02	mg/kg/day	8.1E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	2.5E-05	mg/kg/day	9.7E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	6.7E-06	mg/kg/day	7.5E-05	mg/kg/day	8.9E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	3.0E-04	mg/kg/day	3.9E-03
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	9.1E-06	mg/kg/day	4.0E-02	mg/kg/day	2.3E-04
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.6E-03	mg/kg/day	7.0E-01	mg/kg/day	3.7E-03
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	8.9E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	9.6E-04	mg/kg/day	3.2E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	7.5E-07	mg/kg/day	2.1E-05	mg/kg/day	3.6E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	5.6E-06	mg/kg/day	5.0E-03	mg/kg/day	1.1E-03
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	8.0E-04	mg/kg/day	3.4E-03
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	6.8E-07	mg/kg/day	5.0E-03	mg/kg/day	1.4E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.1E-06	mg/kg/day	1.3E-04	mg/kg/day	2.4E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	3.0E-01	mg/kg/day	7.3E-04
			Exp. Route Total								NA					6.1E-01
		Exposure Point Total									NA					8.4E-01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	6.8E-02	mg/kg/day	1.0E+00	mg/kg/day	6.8E-02
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	4.0E-04	mg/kg/day	8.0E-02
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	3.0E-04	mg/kg/day	1.1E-01
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	2.8E-03	mg/kg/day	2.0E-01	mg/kg/day	1.4E-02
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	5.0E-04	mg/kg/day	1.2E-01
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	3.0E-03	mg/kg/day	2.8E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	7.2E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	4.0E-02	mg/kg/day	5.6E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	6.5E-02	mg/kg/day	7.0E-01	mg/kg/day	9.2E-02
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.4E-02	mg/kg/day	3.1E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.2E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	5.0E-03	mg/kg/day	2.8E-02
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	2.0E-02	mg/kg/day	1.7E-02
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	5.0E-03	mg/kg/day	3.4E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	5.4E-01	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	7.8E-05	mg/kg/day	5.0E-03	mg/kg/day	1.6E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	9.0E-03	mg/kg/day	3.0E-01	mg/kg/day	3.0E-02
			Exp. Route Total								NA					1.2E+00

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	1.0E+00	mg/kg/day	3.8E-04
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	6.0E-05	mg/kg/day	3.0E-03
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	3.0E-04	mg/kg/day	6.1E-04
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	1.4E-02	mg/kg/day	1.1E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	2.5E-05	mg/kg/day	1.3E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	9.2E-07	mg/kg/day	7.5E-05	mg/kg/day	1.2E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	3.0E-04	mg/kg/day	5.3E-04
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	4.0E-02	mg/kg/day	3.1E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	7.0E-01	mg/kg/day	5.1E-04
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	9.6E-04	mg/kg/day	4.4E-02
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	2.1E-05	mg/kg/day	4.9E-03
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	7.8E-07	mg/kg/day	5.0E-03	mg/kg/day	1.6E-04
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	3.8E-07	mg/kg/day	8.0E-04	mg/kg/day	4.7E-04
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	9.4E-08	mg/kg/day	5.0E-03	mg/kg/day	1.9E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.0E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.6E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.3E-07	mg/kg/day	1.3E-04	mg/kg/day	3.3E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	3.0E-05	mg/kg/day	3.0E-01	mg/kg/day	1.0E-04
			Exp. Route Total								NA					8.5E-02
		Exposure Point Total									NA					1.3E+00

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	2.7E-02	mg/kg/day	1.0E+00	mg/kg/day	2.7E-02
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	4.0E-04	mg/kg/day	3.2E-02
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	3.0E-04	mg/kg/day	4.4E-02
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	2.0E-01	mg/kg/day	5.6E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	5.0E-04	mg/kg/day	4.8E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	3.0E-03	mg/kg/day	1.1E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.6E-02
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	4.0E-02	mg/kg/day	2.3E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.6E-02	mg/kg/day	7.0E-01	mg/kg/day	3.7E-02
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	8.8E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	3.0E-03	mg/kg/day	2.4E-02	mg/kg/day	1.3E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	7.4E-06	mg/kg/day	3.0E-04	mg/kg/day	2.5E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	5.6E-05	mg/kg/day	5.0E-03	mg/kg/day	1.1E-02
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	2.0E-02	mg/kg/day	6.8E-03
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	6.7E-06	mg/kg/day	5.0E-03	mg/kg/day	1.3E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.2E-01	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	5.0E-03	mg/kg/day	6.2E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	3.0E-01	mg/kg/day	1.2E-02
			Exp. Route Total								NA					4.9E-01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	5.3E-04	mg/kg/day	1.0E+00	mg/kg/day	5.3E-04
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	2.5E-07	mg/kg/day	6.0E-05	mg/kg/day	4.2E-03
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	2.6E-07	mg/kg/day	3.0E-04	mg/kg/day	8.7E-04
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	2.2E-05	mg/kg/day	1.4E-02	mg/kg/day	1.6E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	4.7E-07	mg/kg/day	2.5E-05	mg/kg/day	1.9E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	7.5E-05	mg/kg/day	1.7E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	2.3E-07	mg/kg/day	3.0E-04	mg/kg/day	7.5E-04
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	4.0E-02	mg/kg/day	4.4E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	7.0E-01	mg/kg/day	7.2E-04
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	9.6E-04	mg/kg/day	6.2E-02
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	2.1E-05	mg/kg/day	7.0E-03
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	5.0E-03	mg/kg/day	2.2E-04
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	5.3E-07	mg/kg/day	8.0E-04	mg/kg/day	6.7E-04
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	5.0E-03	mg/kg/day	2.7E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	4.2E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.1E-07	mg/kg/day	1.3E-04	mg/kg/day	4.7E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	3.0E-01	mg/kg/day	1.4E-04
			Exp. Route Total								NA					1.2E-01
		Exposure Point Total									NA					6.1E-01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	3.1E-01	mg/m^3	NA	NA	NA	NA	NA	1.3E-02	mg/m^3	5.0E-03	mg/m3	2.6E+00
				Antimony	1.5E-04	mg/m^3	NA	NA	NA	NA	NA	6.2E-06	mg/m^3	NA	NA	NA
				Arsenic	1.5E-04	mg/m^3	NA	NA	NA	NA	NA	6.4E-06	mg/m^3	1.5E-05	mg/m3	4.3E-01
				Barium	1.3E-02	mg/m^3	NA	NA	NA	NA	NA	5.4E-04	mg/m^3	5.0E-04	mg/m3	1.1E+00
				Cadmium (water)	2.8E-04	mg/m^3	NA	NA	NA	NA	NA	1.2E-05	mg/m^3	1.0E-05	mg/m3	1.2E+00
				Chromium (hexavalent)	3.8E-04	mg/m^3	NA	NA	NA	NA	NA	1.6E-05	mg/m^3	8.0E-06	mg/m3	2.0E+00
				Cobalt	3.3E-04	mg/m^3	NA	NA	NA	NA	NA	1.4E-05	mg/m^3	6.0E-06	mg/m3	2.3E+00
				Copper	1.0E-03	mg/m^3	NA	NA	NA	NA	NA	4.4E-05	mg/m^3	NA	NA	NA
				Iron	3.0E-01	mg/m^3	NA	NA	NA	NA	NA	1.2E-02	mg/m^3	NA	NA	NA
				Lead	1.0E-03	mg/m^3	NA	NA	NA	NA	NA	4.3E-05	mg/m^3	NA	NA	NA
				Manganese (non-diet)	3.5E-02	mg/m^3	NA	NA	NA	NA	NA	1.5E-03	mg/m^3	5.0E-05	mg/m3	2.9E+01
				Mercury (HgCl)	8.6E-05	mg/m^3	NA	NA	NA	NA	NA	3.6E-06	mg/m^3	NA	NA	NA
				Molybdenum	6.5E-04	mg/m^3	NA	NA	NA	NA	NA	2.7E-05	mg/m^3	NA	NA	NA
				Nickel	1.6E-03	mg/m^3	NA	NA	NA	NA	NA	6.6E-05	mg/m^3	9.0E-05	mg/m3	7.3E-01
				Selenium	7.8E-05	mg/m^3	NA	NA	NA	NA	NA	3.3E-06	mg/m^3	2.0E-02	mg/m3	1.6E-04
				Silica (as SIO2)	2.5E+00	mg/m^3	NA	NA	NA	NA	NA	1.0E-01	mg/m^3	NA	NA	NA
				Thallium	1.3E-04	mg/m^3	NA	NA	NA	NA	NA	5.5E-06	mg/m^3	NA	NA	NA
				Vanadium	3.6E-04	mg/m^3	NA	NA	NA	NA	NA	1.5E-05	mg/m^3	1.0E-04	mg/m3	1.5E-01
				Zinc	4.2E-02	mg/m^3	NA	NA	NA	NA	NA	1.7E-03	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					4.0E+01
		Exposure Point Total									NA					4.0E+01
	Exposure Medium Total										NA					4.2E+01
Medium Total											NA					4.2E+01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	1.0E+00	mg/kg/day	6.6E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.8E-01
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	4.1E-05	mg/kg/day	3.0E-04	mg/kg/day	1.4E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-01	mg/kg/day	1.6E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	2.0E-03	mg/kg/day	6.9E-03
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	1.0E-03	mg/kg/day	8.5E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	1.5E+00	mg/kg/day	3.9E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-02	mg/kg/day	1.8E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	7.0E-01	mg/kg/day	2.0E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.4E-01	mg/kg/day	7.6E-02
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	1.0E-04	mg/kg/day	5.3E-01
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	2.0E-02	mg/kg/day	5.9E-03
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-03	mg/kg/day	5.0E-03	mg/kg/day	2.1E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	5.0E-03	mg/kg/day	6.7E-02
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	5.0E-03	mg/kg/day	4.6E-02
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	3.0E-01	mg/kg/day	1.3E-01
			Exp. Route Total								NA					2.3E+00
		Exposure Point Total									NA					2.3E+00

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	6.0E-02	mg/kg/day	1.0E+00	mg/kg/day	6.0E-02
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-04	mg/kg/day	8.3E-01
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-02	mg/kg/day	2.0E-01	mg/kg/day	2.2E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	2.0E-03	mg/kg/day	8.1E-02
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	2.7E-04	mg/kg/day	1.0E-03	mg/kg/day	2.7E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	2.3E-04	mg/kg/day	1.5E+00	mg/kg/day	1.5E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	2.9E-05	mg/kg/day	3.0E-04	mg/kg/day	9.7E-02
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	4.0E-02	mg/kg/day	3.3E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	7.2E-02	mg/kg/day	7.0E-01	mg/kg/day	1.0E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	5.2E-01	mg/kg/day	1.4E-01	mg/kg/day	3.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	1.0E-04	mg/kg/day	5.1E-02
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.3E-03
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	5.0E-03	mg/kg/day	7.5E-01
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	2.7E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	5.0E-03	mg/kg/day	6.2E-02
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	3.0E-01	mg/kg/day	6.6E-01
			Exp. Route Total								NA					6.9E+00
		Exposure Point Total									NA					6.9E+00

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	1.5E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	3.0E-04	mg/kg/day	6.3E-02
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	2.0E-01	mg/kg/day	7.7E-03
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.0E-03	mg/kg/day	3.4E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-05	mg/kg/day	1.0E-03	mg/kg/day	2.0E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	1.5E+00	mg/kg/day	1.0E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-02	mg/kg/day	5.0E-03
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	2.8E-03	mg/kg/day	7.0E-01	mg/kg/day	4.0E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.4E-01	mg/kg/day	9.9E-03
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-06	mg/kg/day	1.0E-04	mg/kg/day	5.9E-02
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	2.0E-02	mg/kg/day	2.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	5.0E-03	mg/kg/day	5.7E-02
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	6.9E-05	mg/kg/day	5.0E-03	mg/kg/day	1.4E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	9.3E-03	mg/kg/day	3.0E-01	mg/kg/day	3.1E-02
			Exp. Route Total								NA					2.8E-01
		Exposure Point Total									NA					2.8E-01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	4.8E-03	mg/kg/day	1.0E+00	mg/kg/day	4.8E-03
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	4.0E-04	mg/kg/day	7.6E-01
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	3.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	2.0E-01	mg/kg/day	5.3E-04
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	3.9E-05	mg/kg/day	2.0E-03	mg/kg/day	2.0E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E-03	mg/kg/day	4.6E-02
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	1.5E+00	mg/kg/day	2.1E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	4.0E-02	mg/kg/day	3.6E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-02	mg/kg/day	7.0E-01	mg/kg/day	5.4E-02
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	5.1E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	1.4E-01	mg/kg/day	2.4E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	5.7E-05	mg/kg/day	1.0E-04	mg/kg/day	5.7E-01
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	2.0E-02	mg/kg/day	1.8E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	4.5E-04	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	4.5E-02	mg/kg/day	3.0E-01	mg/kg/day	1.5E-01
			Exp. Route Total								NA					2.0E+00
		Exposure Point Total									NA					2.0E+00
	Exposure Medium Total										NA					1.1E+01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	7.4E-01	mg/kg/day	1.0E+00	mg/kg/day	7.4E-01
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	3.0E-04	mg/kg/day	9.7E-01
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	2.0E-01	mg/kg/day	2.0E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	7.9E-05	mg/kg/day	2.0E-03	mg/kg/day	3.9E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-02	mg/kg/day	1.0E-03	mg/kg/day	2.8E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	1.5E+00	mg/kg/day	3.4E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	7.1E-03	mg/kg/day	3.0E-04	mg/kg/day	2.4E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-02	mg/kg/day	4.0E-02	mg/kg/day	9.1E-01
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+01	mg/kg/day	7.0E-01	mg/kg/day	1.7E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	5.7E-01	mg/kg/day	1.4E-01	mg/kg/day	4.1E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	8.6E-05	mg/kg/day	1.0E-04	mg/kg/day	8.6E-01
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	2.0E-02	mg/kg/day	1.6E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.5E-02
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	5.0E-03	mg/kg/day	9.5E-01
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+00	mg/kg/day	3.0E-01	mg/kg/day	9.1E+00
			Exp. Route Total								NA					8.8E+01
		Exposure Point Total									NA					8.8E+01

TABLE 7.36.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	3.0E-04	mg/kg/day	7.2E-04
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	2.5E-05	mg/kg/day	6.7E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.4E-03
		Exposure Point Total									NA					7.4E-03
	Exposure Medium Total										NA					8.8E+01
Medium Total											NA					1.0E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					1E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.36.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	312	234
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.9E+00	1.0E-03	6.0	1.1E-05	6.0	1.1E-05	7.0E+01
Antimony	9.0E-04	1.0E-03	6.0	5.4E-09	6.0	5.4E-09	3.3E-02
Arsenic	9.2E-04	1.0E-03	6.0	5.5E-09	6.0	5.5E-09	3.4E-02
Barium	7.9E-02	1.0E-03	6.0	4.7E-07	6.0	4.7E-07	2.9E+00
Cadmium (water)	1.7E-03	1.0E-03	6.0	1.0E-08	6.0	1.0E-08	6.3E-02
Chromium (hexavalent)	2.3E-03	2.0E-03	6.0	2.8E-08	6.0	2.8E-08	1.7E-01
Cobalt	2.0E-03	4.0E-04	6.0	4.8E-09	6.0	4.8E-09	3.0E-02
Copper	6.3E-03	1.0E-03	6.0	3.8E-08	6.0	3.8E-08	2.4E-01
Iron	1.8E+00	1.0E-03	6.0	1.1E-05	6.0	1.1E-05	6.7E+01
Lead	6.2E-03	1.0E-04	6.0	3.7E-09	6.0	3.7E-09	2.3E-02
Manganese (non-diet)	2.1E-01	1.0E-03	6.0	1.3E-06	6.0	1.3E-06	7.9E+00
Mercury (HgCl)	5.2E-04	1.0E-03	6.0	3.1E-09	6.0	3.1E-09	1.9E-02
Molybdenum	3.9E-03	1.0E-03	6.0	2.3E-08	6.0	2.3E-08	1.5E-01
Nickel	9.5E-03	2.0E-04	6.0	1.1E-08	6.0	1.1E-08	7.1E-02
Selenium	4.7E-04	1.0E-03	6.0	2.8E-09	6.0	2.8E-09	1.8E-02
Silica (as SIO2)	1.5E+01	1.0E-03	6.0	9.1E-05	6.0	9.1E-05	5.6E+02
Thallium	8.0E-04	1.0E-03	6.0	4.8E-09	6.0	4.8E-09	3.0E-02
Vanadium	2.2E-03	1.0E-03	6.0	1.3E-08	6.0	1.3E-08	8.1E-02
Zinc	2.5E-01	6.0E-04	6.0	9.1E-07	6.0	9.1E-07	5.6E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.36.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	6
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.9E+00	1.0E-03	0.71	1.3E-06	0.54	1.0E-06	9.7E+00
Antimony	9.0E-04	1.0E-03	0.71	6.4E-10	0.54	4.9E-10	4.6E-03
Arsenic	9.2E-04	1.0E-03	0.71	6.6E-10	0.54	5.0E-10	4.8E-03
Barium	7.9E-02	1.0E-03	0.71	5.6E-08	0.54	4.2E-08	4.1E-01
Cadmium (water)	1.7E-03	1.0E-03	0.71	1.2E-09	0.54	9.1E-10	8.7E-03
Chromium (hexavalent)	2.3E-03	2.0E-03	0.71	3.3E-09	0.54	2.5E-09	2.4E-02
Cobalt	2.0E-03	4.0E-04	0.71	5.7E-10	0.54	4.3E-10	4.1E-03
Copper	6.3E-03	1.0E-03	0.71	4.5E-09	0.54	3.4E-09	3.3E-02
Iron	1.8E+00	1.0E-03	0.71	1.3E-06	0.54	9.8E-07	9.3E+00
Lead	6.2E-03	1.0E-04	0.71	4.4E-10	0.54	3.3E-10	3.2E-03
Manganese (non-diet)	2.1E-01	1.0E-03	0.71	1.5E-07	0.54	1.1E-07	1.1E+00
Mercury (HgCl)	5.2E-04	1.0E-03	0.71	3.7E-10	0.54	2.8E-10	2.7E-03
Molybdenum	3.9E-03	1.0E-03	0.71	2.8E-09	0.54	2.1E-09	2.0E-02
Nickel	9.5E-03	2.0E-04	0.71	1.4E-09	0.54	1.0E-09	9.8E-03
Selenium	4.7E-04	1.0E-03	0.71	3.4E-10	0.54	2.6E-10	2.4E-03
Silica (as SIO2)	1.5E+01	1.0E-03	0.71	1.1E-05	0.54	8.2E-06	7.8E+01
Thallium	8.0E-04	1.0E-03	0.71	5.7E-10	0.54	4.3E-10	4.1E-03
Vanadium	2.2E-03	1.0E-03	0.71	1.5E-09	0.54	1.2E-09	1.1E-02
Zinc	2.5E-01	6.0E-04	0.71	1.1E-07	0.54	8.2E-08	7.8E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.36.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Exposure Scenario: Sweat Lodge

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	365	365
Exposure Duration	ED	years	64	4
Body Weight	BW	kg	70	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.9E+00	1.0E-03	1.0	1.9E-06	1.0	1.9E-06	1.4E+01
Antimony	9.0E-04	1.0E-03	1.0	9.0E-10	1.0	9.0E-10	6.5E-03
Arsenic	9.2E-04	1.0E-03	1.0	9.2E-10	1.0	9.2E-10	6.6E-03
Barium	7.9E-02	1.0E-03	1.0	7.9E-08	1.0	7.9E-08	5.6E-01
Cadmium (water)	1.7E-03	1.0E-03	1.0	1.7E-09	1.0	1.7E-09	1.2E-02
Chromium (hexavalent)	2.3E-03	2.0E-03	1.0	4.6E-09	1.0	4.6E-09	3.3E-02
Cobalt	2.0E-03	4.0E-04	1.0	8.0E-10	1.0	8.0E-10	5.8E-03
Copper	6.3E-03	1.0E-03	1.0	6.3E-09	1.0	6.3E-09	4.5E-02
Iron	1.8E+00	1.0E-03	1.0	1.8E-06	1.0	1.8E-06	1.3E+01
Lead	6.2E-03	1.0E-04	1.0	6.2E-10	1.0	6.2E-10	4.4E-03
Manganese (non-diet)	2.1E-01	1.0E-03	1.0	2.1E-07	1.0	2.1E-07	1.5E+00
Mercury (HgCl)	5.2E-04	1.0E-03	1.0	5.2E-10	1.0	5.2E-10	3.7E-03
Molybdenum	3.9E-03	1.0E-03	1.0	3.9E-09	1.0	3.9E-09	2.8E-02
Nickel	9.5E-03	2.0E-04	1.0	1.9E-09	1.0	1.9E-09	1.4E-02
Selenium	4.7E-04	1.0E-03	1.0	4.7E-10	1.0	4.7E-10	3.4E-03
Silica (as SIO2)	1.5E+01	1.0E-03	1.0	1.5E-05	1.0	1.5E-05	1.1E+02
Thallium	8.0E-04	1.0E-03	1.0	8.0E-10	1.0	8.0E-10	5.7E-03
Vanadium	2.2E-03	1.0E-03	1.0	2.2E-09	1.0	2.2E-09	1.6E-02
Zinc	2.5E-01	6.0E-04	1.0	1.5E-07	1.0	1.5E-07	1.1E+00

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	1.8E-01	mg/kg/day	1.0E+00	mg/kg/day	1.8E-01
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	4.0E-04	mg/kg/day	1.1E-01
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	3.0E-04	mg/kg/day	7.5E-01
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	9.6E-03	mg/kg/day	2.0E-01	mg/kg/day	4.8E-02
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.7E-05	mg/kg/day	2.0E-03	mg/kg/day	2.3E-02
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	8.9E-04	mg/kg/day	1.0E-03	mg/kg/day	8.9E-01
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.5E+00	mg/kg/day	9.5E-04
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	5.9E-04	mg/kg/day	3.0E-04	mg/kg/day	2.0E+00
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	5.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.4E-02
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	1.1E+00	mg/kg/day	7.0E-01	mg/kg/day	1.6E+00
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	2.0E-03	mg/kg/day	6.2E-01
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	2.4E-02	mg/kg/day	1.0E+00
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	3.0E-04	mg/kg/day	1.3E-02
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	5.0E-03	mg/kg/day	4.6E-01
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	8.3E-04	mg/kg/day	2.0E-02	mg/kg/day	4.2E-02
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	5.0E-03	mg/kg/day	2.9E-02
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	5.1E-02	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	5.0E-03	mg/kg/day	3.6E-02
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	6.0E-01	mg/kg/day	4.1E-03
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	1.8E-06	mg/kg/day	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	5.0E-03	mg/kg/day	3.8E-01
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	8.2E-02	mg/kg/day	3.0E-01	mg/kg/day	2.7E-01
			Exp. Route Total								NA					8.5E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	3.0E-04	mg/kg/day	6.0E-02
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	NA
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	2.5E-05	mg/kg/day	5.7E-02
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.2E-01
		Exposure Point Total									NA					8.6E+00
	Exposure Medium Total										NA					8.6E+00
Medium Total											NA					8.6E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	5.8E-02	mg/kg/day	1.0E+00	mg/kg/day	5.8E-02
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	4.0E-04	mg/kg/day	6.9E-02
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	3.0E-04	mg/kg/day	9.5E-02
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	2.0E-01	mg/kg/day	1.2E-02
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	5.2E-05	mg/kg/day	5.0E-04	mg/kg/day	1.0E-01
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	7.1E-05	mg/kg/day	3.0E-03	mg/kg/day	2.4E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	6.2E-05	mg/kg/day	3.0E-04	mg/kg/day	2.1E-01
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	4.0E-02	mg/kg/day	4.9E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.6E-02	mg/kg/day	7.0E-01	mg/kg/day	7.9E-02
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	6.5E-03	mg/kg/day	2.4E-02	mg/kg/day	2.7E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	3.0E-04	mg/kg/day	5.3E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	5.0E-03	mg/kg/day	2.4E-02
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.5E-02
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.5E-05	mg/kg/day	5.0E-03	mg/kg/day	2.9E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.7E-05	mg/kg/day	5.0E-03	mg/kg/day	1.3E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	7.8E-03	mg/kg/day	3.0E-01	mg/kg/day	2.6E-02
			Exp. Route Total								NA					1.1E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	1.0E+00	mg/kg/day	3.1E-03
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	6.0E-05	mg/kg/day	2.4E-02
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	3.0E-04	mg/kg/day	5.0E-03
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.4E-02	mg/kg/day	9.2E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	2.5E-05	mg/kg/day	1.1E-01
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	7.5E-06	mg/kg/day	7.5E-05	mg/kg/day	1.0E-01
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	3.0E-04	mg/kg/day	4.4E-03
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	4.0E-02	mg/kg/day	2.6E-04
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.9E-03	mg/kg/day	7.0E-01	mg/kg/day	4.2E-03
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	3.4E-04	mg/kg/day	9.6E-04	mg/kg/day	3.6E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	8.5E-07	mg/kg/day	2.1E-05	mg/kg/day	4.0E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	6.4E-06	mg/kg/day	5.0E-03	mg/kg/day	1.3E-03
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	3.1E-06	mg/kg/day	8.0E-04	mg/kg/day	3.9E-03
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	7.7E-07	mg/kg/day	5.0E-03	mg/kg/day	1.5E-04
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.6E-06	mg/kg/day	1.3E-04	mg/kg/day	2.7E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	3.0E-01	mg/kg/day	8.2E-04
			Exp. Route Total								NA					6.9E-01
		Exposure Point Total									NA					1.8E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	9.8E-02	mg/kg/day	1.0E+00	mg/kg/day	9.8E-02
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	4.7E-05	mg/kg/day	4.0E-04	mg/kg/day	1.2E-01
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	3.0E-04	mg/kg/day	1.6E-01
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	4.1E-03	mg/kg/day	2.0E-01	mg/kg/day	2.0E-02
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	8.8E-05	mg/kg/day	5.0E-04	mg/kg/day	1.8E-01
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	3.0E-03	mg/kg/day	4.0E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	3.0E-04	mg/kg/day	3.5E-01
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	3.3E-04	mg/kg/day	4.0E-02	mg/kg/day	8.2E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	9.4E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	2.4E-02	mg/kg/day	4.6E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.0E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	5.0E-03	mg/kg/day	4.1E-02
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	5.0E-04	mg/kg/day	2.0E-02	mg/kg/day	2.5E-02
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	5.0E-03	mg/kg/day	4.9E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	7.9E-01	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-03	mg/kg/day	2.3E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	3.0E-01	mg/kg/day	4.4E-02
			Exp. Route Total								NA					1.8E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	4.3E-04	mg/kg/day	1.0E+00	mg/kg/day	4.3E-04
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	6.0E-05	mg/kg/day	3.4E-03
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	3.0E-04	mg/kg/day	7.1E-04
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.8E-05	mg/kg/day	1.4E-02	mg/kg/day	1.3E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	3.9E-07	mg/kg/day	2.5E-05	mg/kg/day	1.5E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	7.5E-05	mg/kg/day	1.4E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	3.0E-04	mg/kg/day	6.1E-04
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	4.0E-02	mg/kg/day	3.6E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	7.0E-01	mg/kg/day	5.9E-04
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	9.6E-04	mg/kg/day	5.0E-02
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	2.1E-05	mg/kg/day	5.7E-03
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	8.9E-07	mg/kg/day	5.0E-03	mg/kg/day	1.8E-04
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	4.4E-07	mg/kg/day	8.0E-04	mg/kg/day	5.5E-04
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	5.0E-03	mg/kg/day	2.2E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.5E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	5.0E-07	mg/kg/day	1.3E-04	mg/kg/day	3.8E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	3.5E-05	mg/kg/day	3.0E-01	mg/kg/day	1.2E-04
			Exp. Route Total								NA					9.7E-02
		Exposure Point Total									NA					1.9E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	1.3E-01	mg/kg/day	1.0E+00	mg/kg/day	1.3E-01
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	4.0E-04	mg/kg/day	1.5E-01
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	6.2E-05	mg/kg/day	3.0E-04	mg/kg/day	2.1E-01
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	5.2E-03	mg/kg/day	2.0E-01	mg/kg/day	2.6E-02
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-04	mg/kg/day	2.3E-01
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	3.0E-03	mg/kg/day	5.1E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	3.0E-04	mg/kg/day	4.5E-01
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.2E-01	mg/kg/day	7.0E-01	mg/kg/day	1.7E-01
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	4.1E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	2.4E-02	mg/kg/day	5.9E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	3.5E-05	mg/kg/day	3.0E-04	mg/kg/day	1.2E-01
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	2.6E-04	mg/kg/day	5.0E-03	mg/kg/day	5.2E-02
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	6.3E-04	mg/kg/day	2.0E-02	mg/kg/day	3.2E-02
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	5.0E-03	mg/kg/day	6.3E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	5.3E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	5.0E-03	mg/kg/day	2.9E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.7E-02	mg/kg/day	3.0E-01	mg/kg/day	5.6E-02
			Exp. Route Total								NA					2.3E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	1.0E+00	mg/kg/day	8.0E-04
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	3.8E-07	mg/kg/day	6.0E-05	mg/kg/day	6.4E-03
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	3.9E-07	mg/kg/day	3.0E-04	mg/kg/day	1.3E-03
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	1.4E-02	mg/kg/day	2.4E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	7.2E-07	mg/kg/day	2.5E-05	mg/kg/day	2.9E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	2.0E-06	mg/kg/day	7.5E-05	mg/kg/day	2.6E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	3.0E-04	mg/kg/day	1.1E-03
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	2.7E-06	mg/kg/day	4.0E-02	mg/kg/day	6.7E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	7.7E-04	mg/kg/day	7.0E-01	mg/kg/day	1.1E-03
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	2.6E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	9.6E-04	mg/kg/day	9.3E-02
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	2.2E-07	mg/kg/day	2.1E-05	mg/kg/day	1.1E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	5.0E-03	mg/kg/day	3.3E-04
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	8.1E-07	mg/kg/day	8.0E-04	mg/kg/day	1.0E-03
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	5.0E-03	mg/kg/day	4.0E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	6.4E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	9.3E-07	mg/kg/day	1.3E-04	mg/kg/day	7.1E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	6.4E-05	mg/kg/day	3.0E-01	mg/kg/day	2.1E-04
			Exp. Route Total								NA					1.8E-01
		Exposure Point Total									NA					2.5E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	3.1E-01	mg/m^3	NA	NA	NA	NA	NA	1.3E-02	mg/m^3	5.0E-03	mg/m3	2.6E+00
				Antimony	1.5E-04	mg/m^3	NA	NA	NA	NA	NA	6.2E-06	mg/m^3	NA	NA	NA
				Arsenic	1.5E-04	mg/m^3	NA	NA	NA	NA	NA	6.4E-06	mg/m^3	1.5E-05	mg/m3	4.3E-01
				Barium	1.3E-02	mg/m^3	NA	NA	NA	NA	NA	5.4E-04	mg/m^3	5.0E-04	mg/m3	1.1E+00
				Cadmium (water)	2.8E-04	mg/m^3	NA	NA	NA	NA	NA	1.2E-05	mg/m^3	1.0E-05	mg/m3	1.2E+00
				Chromium (hexavalent)	3.8E-04	mg/m^3	NA	NA	NA	NA	NA	1.6E-05	mg/m^3	8.0E-06	mg/m3	2.0E+00
				Cobalt	3.3E-04	mg/m^3	NA	NA	NA	NA	NA	1.4E-05	mg/m^3	6.0E-06	mg/m3	2.3E+00
				Copper	1.0E-03	mg/m^3	NA	NA	NA	NA	NA	4.4E-05	mg/m^3	NA	NA	NA
				Iron	3.0E-01	mg/m^3	NA	NA	NA	NA	NA	1.2E-02	mg/m^3	NA	NA	NA
				Lead	1.0E-03	mg/m^3	NA	NA	NA	NA	NA	4.3E-05	mg/m^3	NA	NA	NA
				Manganese (non-diet)	3.5E-02	mg/m^3	NA	NA	NA	NA	NA	1.5E-03	mg/m^3	5.0E-05	mg/m3	2.9E+01
				Mercury (HgCl)	8.6E-05	mg/m^3	NA	NA	NA	NA	NA	3.6E-06	mg/m^3	NA	NA	NA
				Molybdenum	6.5E-04	mg/m^3	NA	NA	NA	NA	NA	2.7E-05	mg/m^3	NA	NA	NA
				Nickel	1.6E-03	mg/m^3	NA	NA	NA	NA	NA	6.6E-05	mg/m^3	9.0E-05	mg/m3	7.3E-01
				Selenium	7.8E-05	mg/m^3	NA	NA	NA	NA	NA	3.3E-06	mg/m^3	2.0E-02	mg/m3	1.6E-04
				Silica (as SIO2)	2.5E+00	mg/m^3	NA	NA	NA	NA	NA	1.0E-01	mg/m^3	NA	NA	NA
				Thallium	1.3E-04	mg/m^3	NA	NA	NA	NA	NA	5.5E-06	mg/m^3	NA	NA	NA
				Vanadium	3.6E-04	mg/m^3	NA	NA	NA	NA	NA	1.5E-05	mg/m^3	1.0E-04	mg/m3	1.5E-01
				Zinc	4.2E-02	mg/m^3	NA	NA	NA	NA	NA	1.7E-03	mg/m^3	NA	NA	NA
			Exp. Route Total								NA					4.0E+01
		Exposure Point Total									NA					4.0E+01
	Exposure Medium Total										NA					4.6E+01
Medium Total											NA					4.6E+01

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	NA	NA	NA	NA	NA	1.5E-02	mg/kg/day	1.0E+00	mg/kg/day	1.5E-02
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.2E-02	mg/kg	NA	NA	NA	NA	NA	9.5E-05	mg/kg/day	3.0E-04	mg/kg/day	3.2E-01
				Barium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-01	mg/kg/day	3.7E-02
				Beryllium	1.1E-02	mg/kg	NA	NA	NA	NA	NA	3.2E-05	mg/kg/day	2.0E-03	mg/kg/day	1.6E-02
				Cadmium (non-water)	6.6E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-03	mg/kg/day	2.0E-01
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.4E-03	mg/kg/day	1.5E+00	mg/kg/day	9.1E-04
				Cobalt	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-04	mg/kg/day	3.0E-04	mg/kg/day	4.7E-01
				Copper	5.6E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-02	mg/kg/day	4.2E-02
				Iron	1.1E+01	mg/kg	NA	NA	NA	NA	NA	3.3E-02	mg/kg/day	7.0E-01	mg/kg/day	4.6E-02
				Lead	3.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	NA	NA	NA	NA	NA	2.5E-02	mg/kg/day	1.4E-01	mg/kg/day	1.8E-01
				Mercury (MeHg)	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	1.0E-04	mg/kg/day	1.2E+00
				Nickel	9.2E-02	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	8.1E-01	mg/kg	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	5.0E-03	mg/kg/day	4.9E-01
				Silver	2.6E-01	mg/kg	NA	NA	NA	NA	NA	7.9E-04	mg/kg/day	5.0E-03	mg/kg/day	1.6E-01
				Thallium	3.9E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	5.0E-03	mg/kg/day	1.1E-01
				Zinc	3.0E+01	mg/kg	NA	NA	NA	NA	NA	8.9E-02	mg/kg/day	3.0E-01	mg/kg/day	3.0E-01
			Exp. Route Total								NA					5.4E+00
		Exposure Point Total									NA					5.4E+00

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-01	mg/kg/day	1.0E+00	mg/kg/day	1.4E-01
				Arsenic	5.8E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	3.0E-04	mg/kg/day	1.9E+00
				Barium	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-01	mg/kg/day	2.0E-01	mg/kg/day	5.1E-01
				Beryllium	3.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	2.0E-03	mg/kg/day	1.9E-01
				Cadmium (non-water)	6.4E-01	mg/kg	NA	NA	NA	NA	NA	6.4E-04	mg/kg/day	1.0E-03	mg/kg/day	6.4E-01
				Chromium (trivalent)	5.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	1.5E+00	mg/kg/day	3.6E-04
				Cobalt	6.8E-02	mg/kg	NA	NA	NA	NA	NA	6.8E-05	mg/kg/day	3.0E-04	mg/kg/day	2.3E-01
				Copper	3.1E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	4.0E-02	mg/kg/day	7.8E-02
				Iron	1.7E+02	mg/kg	NA	NA	NA	NA	NA	1.7E-01	mg/kg/day	7.0E-01	mg/kg/day	2.4E-01
				Lead	1.9E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	NA	NA	NA	NA	NA	1.2E+00	mg/kg/day	1.4E-01	mg/kg/day	8.7E+00
				Mercury (MeHg)	1.2E-02	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	1.0E-04	mg/kg/day	1.2E-01
				Nickel	3.9E-01	mg/kg	NA	NA	NA	NA	NA	3.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.9E-02
				Selenium	8.7E+00	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	5.0E-03	mg/kg/day	1.7E+00
				Silica (as SIO2)	6.3E+02	mg/kg	NA	NA	NA	NA	NA	6.3E-01	mg/kg/day	NA	NA	NA
				Silver	7.2E-01	mg/kg	NA	NA	NA	NA	NA	7.2E-04	mg/kg/day	5.0E-03	mg/kg/day	1.4E-01
				Zinc	4.6E+02	mg/kg	NA	NA	NA	NA	NA	4.6E-01	mg/kg/day	3.0E-01	mg/kg/day	1.5E+00
			Exp. Route Total								NA					1.6E+01
		Exposure Point Total									NA					1.6E+01

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	NA	NA	NA	NA	NA	3.4E-03	mg/kg/day	1.0E+00	mg/kg/day	3.4E-03
				Arsenic	5.5E-02	mg/kg	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	4.5E+00	mg/kg	NA	NA	NA	NA	NA	3.6E-03	mg/kg/day	2.0E-01	mg/kg/day	1.8E-02
				Beryllium	2.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	2.0E-03	mg/kg/day	8.0E-03
				Cadmium (non-water)	5.9E-02	mg/kg	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	1.0E-03	mg/kg/day	4.8E-02
				Chromium (trivalent)	4.6E-01	mg/kg	NA	NA	NA	NA	NA	3.6E-04	mg/kg/day	1.5E+00	mg/kg/day	2.4E-04
				Copper	5.8E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	4.0E-02	mg/kg/day	1.2E-02
				Iron	8.2E+00	mg/kg	NA	NA	NA	NA	NA	6.6E-03	mg/kg/day	7.0E-01	mg/kg/day	9.4E-03
				Lead	4.8E-01	mg/kg	NA	NA	NA	NA	NA	3.8E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	NA	NA	NA	NA	NA	3.2E-03	mg/kg/day	1.4E-01	mg/kg/day	2.3E-02
				Mercury (MeHg)	1.7E-02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	1.0E-04	mg/kg/day	1.4E-01
				Nickel	1.3E-01	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	2.0E-02	mg/kg/day	5.2E-03
				Selenium	8.3E-01	mg/kg	NA	NA	NA	NA	NA	6.6E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	2.0E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	5.0E-03	mg/kg/day	3.2E-02
				Thallium	5.7E-01	mg/kg	NA	NA	NA	NA	NA	4.6E-04	mg/kg/day	NA	NA	NA
				Zinc	2.7E+01	mg/kg	NA	NA	NA	NA	NA	2.2E-02	mg/kg/day	3.0E-01	mg/kg/day	7.2E-02
			Exp. Route Total								NA					6.5E-01
		Exposure Point Total									NA					6.5E-01

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	1.0E+00	mg/kg/day	1.1E-02
				Antimony	3.1E-01	mg/kg	NA	NA	NA	NA	NA	7.1E-04	mg/kg/day	4.0E-04	mg/kg/day	1.8E+00
				Arsenic	3.9E-02	mg/kg	NA	NA	NA	NA	NA	9.0E-05	mg/kg/day	3.0E-04	mg/kg/day	3.0E-01
				Barium	1.1E-01	mg/kg	NA	NA	NA	NA	NA	2.5E-04	mg/kg/day	2.0E-01	mg/kg/day	1.2E-03
				Beryllium	4.0E-02	mg/kg	NA	NA	NA	NA	NA	9.2E-05	mg/kg/day	2.0E-03	mg/kg/day	4.6E-02
				Cadmium (non-water)	4.7E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-03	mg/kg/day	1.1E-01
				Chromium (trivalent)	3.2E-01	mg/kg	NA	NA	NA	NA	NA	7.3E-04	mg/kg/day	1.5E+00	mg/kg/day	4.9E-04
				Copper	1.5E+00	mg/kg	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	4.0E-02	mg/kg/day	8.4E-02
				Iron	3.8E+01	mg/kg	NA	NA	NA	NA	NA	8.8E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	5.1E-01	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.8E-04	mg/kg/day	1.4E-01	mg/kg/day	5.6E-03
				Mercury (MeHg)	5.8E-02	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	1.0E-04	mg/kg/day	1.3E+00
				Nickel	3.7E-01	mg/kg	NA	NA	NA	NA	NA	8.5E-04	mg/kg/day	2.0E-02	mg/kg/day	4.3E-02
				Selenium	7.8E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Thallium	4.6E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	NA	NA	NA
				Zinc	4.6E+01	mg/kg	NA	NA	NA	NA	NA	1.1E-01	mg/kg/day	3.0E-01	mg/kg/day	3.5E-01
			Exp. Route Total								NA					4.6E+00
		Exposure Point Total									NA					4.6E+00
	Exposure Medium Total										NA					2.7E+01

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	NA	NA	NA	NA	NA	1.7E+00	mg/kg/day	1.0E+00	mg/kg/day	1.7E+00
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-03	mg/kg/day	4.0E-04	mg/kg/day	4.2E+00
				Arsenic	1.5E-01	mg/kg	NA	NA	NA	NA	NA	6.8E-04	mg/kg/day	3.0E-04	mg/kg/day	2.3E+00
				Barium	2.1E+01	mg/kg	NA	NA	NA	NA	NA	9.2E-02	mg/kg/day	2.0E-01	mg/kg/day	4.6E-01
				Beryllium	4.1E-02	mg/kg	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	2.0E-03	mg/kg/day	9.2E-02
				Cadmium (non-water)	1.5E+01	mg/kg	NA	NA	NA	NA	NA	6.6E-02	mg/kg/day	1.0E-03	mg/kg/day	6.6E+01
				Chromium (trivalent)	2.7E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-02	mg/kg/day	1.5E+00	mg/kg/day	7.8E-03
				Cobalt	3.7E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-02	mg/kg/day	3.0E-04	mg/kg/day	5.5E+01
				Copper	1.9E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-02	mg/kg/day	4.0E-02	mg/kg/day	2.1E+00
				Iron	6.1E+03	mg/kg	NA	NA	NA	NA	NA	2.7E+01	mg/kg/day	7.0E-01	mg/kg/day	3.9E+01
				Lead	7.1E+01	mg/kg	NA	NA	NA	NA	NA	3.1E-01	mg/kg/day	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	NA	NA	NA	NA	NA	1.3E+00	mg/kg/day	1.4E-01	mg/kg/day	9.5E+00
				Mercury (MeHg)	4.5E-02	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	1.0E-04	mg/kg/day	2.0E+00
				Nickel	1.7E+00	mg/kg	NA	NA	NA	NA	NA	7.5E-03	mg/kg/day	2.0E-02	mg/kg/day	3.8E-01
				Silver	1.7E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	5.0E-03	mg/kg/day	1.5E-01
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	5.0E-03	mg/kg/day	2.2E+00
				Zinc	1.4E+03	mg/kg	NA	NA	NA	NA	NA	6.4E+00	mg/kg/day	3.0E-01	mg/kg/day	2.1E+01
			Exp. Route Total								NA					2.1E+02
		Exposure Point Total									NA					2.1E+02

TABLE 7.37.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E+00	mg/kg/day	NA
				Antimony	3.8E-01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	6.0E-05	mg/kg/day	NA
				Arsenic	9.1E-01	mg/kg	NA	NA	NA	NA	NA	3.0E-07	mg/kg/day	3.0E-04	mg/kg/day	1.0E-03
				Barium	2.0E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-02	mg/kg/day	NA
				Beryllium	3.8E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-05	mg/kg/day	NA
				Cadmium (non-water)	2.1E+01	mg/kg	NA	NA	NA	NA	NA	2.4E-07	mg/kg/day	2.5E-05	mg/kg/day	9.5E-03
				Chromium (trivalent)	3.7E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	2.0E-02	mg/kg/day	NA
				Cobalt	6.2E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-04	mg/kg/day	NA
				Copper	2.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	4.0E-02	mg/kg/day	NA
				Iron	5.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	7.0E-01	mg/kg/day	NA
				Lead	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.4E-01	mg/kg/day	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.0E-04	mg/kg/day	NA
				Nickel	1.9E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	8.0E-04	mg/kg/day	NA
				Vanadium	2.5E+00	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	1.3E-04	mg/kg/day	NA
				Zinc	1.8E+03	mg/kg	NA	NA	NA	NA	NA	NA	mg/kg/day	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.1E-02
		Exposure Point Total									NA					1.1E-02
	Exposure Medium Total										NA					2.1E+02
Medium Total											NA					2.3E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											NA					3E+02

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	8.0E+03	mg/kg	5.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.0E+00	mg/kg	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.6E+01	mg/kg	6.3E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	9.5E-05	NA	NA	NA	NA	NA
				Barium	4.2E+02	mg/kg	2.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Boron	1.2E+01	mg/kg	7.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.9E+01	mg/kg	2.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	6.2E+01	mg/kg	4.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.6E+01	mg/kg	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.4E+01	mg/kg	1.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	4.9E+04	mg/kg	3.1E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.5E+02	mg/kg	9.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.1E+03	mg/kg	6.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.7E-01	mg/kg	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	6.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.6E+01	mg/kg	2.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	9.7E+02	mg/kg	6.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	4.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	2.2E+03	mg/kg	1.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	1.1E+02	mg/kg	6.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-02	mg/kg	5.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	5.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.6E+03	mg/kg	2.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								9.5E-05					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.6E+01	mg/kg	1.2E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.9E-05	NA	NA	NA	NA	NA
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.9E+01	mg/kg	9.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.9E-05					NA
		Exposure Point Total									1.1E-04					NA
	Exposure Medium Total										1.1E-04					NA
Medium Total											1.1E-04					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.9E+00	mg/L	1.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	7.9E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	8.1E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.2E-05	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	6.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	2.0E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.1E-05	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	1.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	5.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	5.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	1.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	4.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	3.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	8.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	4.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.3E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	7.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	2.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.3E-05					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.9E+00	mg/L	2.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	1.3E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.0E-06	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	2.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	6.7E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	1.4E-04	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	9.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	2.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	9.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	3.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	7.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	2.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	6.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	2.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	3.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.5E-04					NA
		Exposure Point Total									1.8E-04					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.9E+00	mg/L	7.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	3.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.1E-05	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	2.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	6.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	8.6E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	5.1E-05	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	7.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	2.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	6.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	2.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	7.8E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	1.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	1.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	5.6E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	8.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	9.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.0E-04					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	3.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	1.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	1.9E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.8E-07	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	3.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	9.3E-07	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.0E-05	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	1.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	1.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	4.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	1.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	7.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	3.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	9.5E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	3.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	4.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	3.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.0E-05					NA
		Exposure Point Total									1.2E-04					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Ingestion	Aluminum	1.9E+00	mg/L	3.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	1.6E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.3E-05	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	1.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	2.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	3.9E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.3E-05	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	3.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	3.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	8.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	6.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	1.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	8.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	2.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	1.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	3.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	4.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.6E-05					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	5.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	2.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	2.6E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.9E-07	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	4.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	1.3E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.2E-05	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	2.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	1.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	1.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	5.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	2.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	6.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	4.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.2E-05					NA
		Exposure Point Total									6.8E-05					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Inhalation	Aluminum	3.1E-01	mg/m^3	1.3E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	1.5E-04	mg/m^3	6.0E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.5E-04	mg/m^3	6.2E-06	mg/m^3	4.3E-03	1/(µg/m3)	2.7E-05	NA	NA	NA	NA	NA
				Barium	1.3E-02	mg/m^3	5.3E-04	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	2.8E-04	mg/m^3	1.1E-05	mg/m^3	1.8E-03	1/(µg/m3)	2.0E-05	NA	NA	NA	NA	NA
				Chromium (hexavalent)	3.8E-04	mg/m^3	1.6E-05	mg/m^3	8.4E-02	1/(µg/m3)	1.0E-03	NA	NA	NA	NA	NA
				Cobalt	3.3E-04	mg/m^3	1.3E-05	mg/m^3	9.0E-03	1/(µg/m3)	1.2E-04	NA	NA	NA	NA	NA
				Copper	1.0E-03	mg/m^3	4.2E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.0E-01	mg/m^3	1.2E-02	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.0E-03	mg/m^3	4.1E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	3.5E-02	mg/m^3	1.4E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	8.6E-05	mg/m^3	3.5E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	6.5E-04	mg/m^3	2.6E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.6E-03	mg/m^3	6.4E-05	mg/m^3	2.6E-04	1/(µg/m3)	1.7E-05	NA	NA	NA	NA	NA
				Selenium	7.8E-05	mg/m^3	3.2E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	2.5E+00	mg/m^3	1.0E-01	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	1.3E-04	mg/m^3	5.4E-06	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	3.6E-04	mg/m^3	1.5E-05	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.2E-02	mg/m^3	1.7E-03	mg/m^3	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.2E-03					NA
		Exposure Point Total									1.2E-03					NA
	Exposure Medium Total										1.6E-03					NA
Medium Total											1.6E-03					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	5.2E+00	mg/kg	7.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.2E-02	mg/kg	4.5E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.8E-05	NA	NA	NA	NA	NA
				Barium	2.5E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.1E-02	mg/kg	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.6E-02	mg/kg	9.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	6.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	4.7E-02	mg/kg	6.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.6E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.1E+01	mg/kg	1.6E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	3.6E-01	mg/kg	5.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	8.3E+00	mg/kg	1.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.1E-02	mg/kg	5.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.2E-02	mg/kg	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.1E-01	mg/kg	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.6E-01	mg/kg	3.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	3.9E-01	mg/kg	5.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	1.8E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.0E+01	mg/kg	4.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.8E-05					NA
		Exposure Point Total									6.8E-05					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Ingestion	Aluminum	1.4E+02	mg/kg	6.7E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.8E-01	mg/kg	2.8E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.1E-04	NA	NA	NA	NA	NA
				Barium	1.0E+02	mg/kg	4.8E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	6.4E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	5.4E-01	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.8E-02	mg/kg	3.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	3.1E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.7E+02	mg/kg	8.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.9E+00	mg/kg	9.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	1.2E+03	mg/kg	5.8E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.2E-02	mg/kg	5.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.9E-01	mg/kg	1.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.7E+00	mg/kg	4.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	6.3E+02	mg/kg	3.0E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	7.2E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+02	mg/kg	2.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.1E-04					NA
		Exposure Point Total									4.1E-04					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Ingestion	Aluminum	4.3E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	5.5E-02	mg/kg	2.1E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.2E-05	NA	NA	NA	NA	NA
				Barium	4.5E+00	mg/kg	1.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E-02	mg/kg	7.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	5.9E-02	mg/kg	2.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	4.6E-01	mg/kg	1.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.8E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	8.2E+00	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	4.8E-01	mg/kg	1.8E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.0E+00	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	1.7E-02	mg/kg	6.6E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.3E-01	mg/kg	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.3E-01	mg/kg	3.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	2.0E-01	mg/kg	7.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	5.7E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.7E+01	mg/kg	1.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.2E-05					NA
		Exposure Point Total									3.2E-05					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Ingestion	Aluminum	4.9E+00	mg/kg	5.4E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.1E-01	mg/kg	3.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.9E-02	mg/kg	4.3E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	6.4E-05	NA	NA	NA	NA	NA
				Barium	1.1E-01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.0E-02	mg/kg	4.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	4.7E-02	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.2E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.5E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+01	mg/kg	4.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	5.1E-01	mg/kg	5.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.4E-01	mg/kg	3.7E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.8E-02	mg/kg	6.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.7E-01	mg/kg	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	7.8E-01	mg/kg	8.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	4.6E-01	mg/kg	5.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	4.6E+01	mg/kg	5.0E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-05					NA
		Exposure Point Total									6.4E-05					NA
	Exposure Medium Total										5.8E-04					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Ingestion	Aluminum	3.9E+02	mg/kg	8.2E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	8.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.5E-01	mg/kg	3.2E-04	mg/kg/day	1.5E+00	1/(mg/kg/day)	4.8E-04	NA	NA	NA	NA	NA
				Barium	2.1E+01	mg/kg	4.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	4.1E-02	mg/kg	8.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	1.5E+01	mg/kg	3.2E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	2.7E+00	mg/kg	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	3.7E+00	mg/kg	7.9E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	1.9E+01	mg/kg	4.1E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	6.1E+03	mg/kg	1.3E+01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	7.1E+01	mg/kg	1.5E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	3.0E+02	mg/kg	6.4E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	4.5E-02	mg/kg	9.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.7E+00	mg/kg	3.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.7E-01	mg/kg	3.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	5.3E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.4E+03	mg/kg	3.1E+00	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.8E-04					NA
		Exposure Point Total									4.8E-04					NA

TABLE 7.38.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Dermal	Aluminum	4.5E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	3.8E-01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.1E-01	mg/kg	2.2E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	3.3E-07	NA	NA	NA	NA	NA
				Barium	2.0E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	3.8E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	2.1E+01	mg/kg	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.7E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	6.2E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.3E+01	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	5.6E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.1E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	4.2E+02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	9.4E-02	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	1.9E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.5E+00	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.8E+03	mg/kg	NA	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								3.3E-07					NA
		Exposure Point Total									3.3E-07					NA
	Exposure Medium Total										4.9E-04					NA
Medium Total											1.1E-03					NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)											3E-03					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.38.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	COPC	EPC		Cancer Risk Calculations											
							Intake					CSF/Unit Risk						
					Value	Units	Value				Units	Value				Units	Cancer Risk (3)	
							0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs		0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)			
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	2.3E-03	mg/L	2.0E-06	4.1E-06	2.2E-06	2.2E-06	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	2.1E-05	
			Dermal	Chromium (hexavalent)	2.3E-03	mg/L	2.2E-07	4.3E-07	9.5E-07	9.5E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	1.4E-04	
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	2.3E-03	mg/L	3.4E-06	6.9E-06	1.2E-05	1.2E-05	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	5.1E-05	
			Dermal	Chromium (hexavalent)	2.3E-03	mg/L	3.0E-08	6.0E-08	1.3E-07	1.3E-07	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.0E-05	
		Surface Water (Sweat Lodge)	Ingestion	Chromium (hexavalent)	2.3E-03	mg/L	n/a	8.8E-06	4.7E-06	4.7E-06	mg/kg-day	n/a	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	2.3E-05	
			Dermal	Chromium (hexavalent)	2.3E-03	mg/L	n/a	1.1E-07	1.9E-07	1.9E-07	mg/kg-day	n/a	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.2E-05	
		Water Vapor (Sweat Lodge)	Inhalation	Chromium (hexavalent)	3.8E-04	mg/m^3	n/a	9.1E-07	2.3E-06	2.3E-06	mg/m^3	n/a	2.5E-01	2.5E-01	8.4E-02	$1/(\mu g/m^3)$	1.0E-03	

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
COPC = chemical of potential concern
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
$\mu g/m^3$= microgram per cubic meter
mg/m^3= milligram per cubic meter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 7.39.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	8.0E+03	mg/kg	1.1E-02	mg/kg/day	NA	NA	NA	3.1E-02	mg/kg/day	1.0E+00	mg/kg/day	3.1E-02
				Antimony	2.0E+00	mg/kg	2.7E-06	mg/kg/day	NA	NA	NA	7.6E-06	mg/kg/day	4.0E-04	mg/kg/day	1.9E-02
				Arsenic	1.6E+01	mg/kg	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	3.9E-05	mg/kg/day	3.0E-04	mg/kg/day	1.3E-01
				Barium	4.2E+02	mg/kg	5.9E-04	mg/kg/day	NA	NA	NA	1.6E-03	mg/kg/day	2.0E-01	mg/kg/day	8.2E-03
				Beryllium	2.0E+00	mg/kg	2.9E-06	mg/kg/day	NA	NA	NA	8.0E-06	mg/kg/day	2.0E-03	mg/kg/day	4.0E-03
				Boron	1.2E+01	mg/kg	1.7E-05	mg/kg/day	NA	NA	NA	4.8E-05	mg/kg/day	2.0E-01	mg/kg/day	2.4E-04
				Cadmium (non-water)	3.9E+01	mg/kg	5.5E-05	mg/kg/day	NA	NA	NA	1.5E-04	mg/kg/day	1.0E-03	mg/kg/day	1.5E-01
				Chromium (trivalent)	6.2E+01	mg/kg	8.7E-05	mg/kg/day	NA	NA	NA	2.4E-04	mg/kg/day	1.5E+00	mg/kg/day	1.6E-04
				Cobalt	2.6E+01	mg/kg	3.6E-05	mg/kg/day	NA	NA	NA	1.0E-04	mg/kg/day	3.0E-04	mg/kg/day	3.4E-01
				Copper	2.4E+01	mg/kg	3.4E-05	mg/kg/day	NA	NA	NA	9.6E-05	mg/kg/day	4.0E-02	mg/kg/day	2.4E-03
				Iron	4.9E+04	mg/kg	6.9E-02	mg/kg/day	NA	NA	NA	1.9E-01	mg/kg/day	7.0E-01	mg/kg/day	2.7E-01
				Lead	1.5E+02	mg/kg	2.0E-04	mg/kg/day	NA	NA	NA	5.7E-04	mg/kg/day	NA	NA	NA
				Lithium	5.5E+01	mg/kg	7.6E-05	mg/kg/day	NA	NA	NA	2.1E-04	mg/kg/day	2.0E-03	mg/kg/day	1.1E-01
				Manganese (non-diet)	1.1E+03	mg/kg	1.5E-03	mg/kg/day	NA	NA	NA	4.2E-03	mg/kg/day	2.4E-02	mg/kg/day	1.8E-01
				Mercury (HgCl)	1.7E-01	mg/kg	2.4E-07	mg/kg/day	NA	NA	NA	6.7E-07	mg/kg/day	3.0E-04	mg/kg/day	2.2E-03
				Molybdenum	1.0E+02	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	3.9E-04	mg/kg/day	5.0E-03	mg/kg/day	7.8E-02
				Nickel	3.6E+01	mg/kg	5.1E-05	mg/kg/day	NA	NA	NA	1.4E-04	mg/kg/day	2.0E-02	mg/kg/day	7.1E-03
				Phosphorus	9.7E+02	mg/kg	1.3E-03	mg/kg/day	NA	NA	NA	3.8E-03	mg/kg/day	NA	NA	NA
				Selenium	6.3E+00	mg/kg	8.8E-06	mg/kg/day	NA	NA	NA	2.5E-05	mg/kg/day	5.0E-03	mg/kg/day	4.9E-03
				Silica (as SIO2)	2.2E+03	mg/kg	3.1E-03	mg/kg/day	NA	NA	NA	8.8E-03	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	1.1E-05	mg/kg/day	NA	NA	NA	3.1E-05	mg/kg/day	5.0E-03	mg/kg/day	6.3E-03
				Strontium	1.1E+02	mg/kg	1.5E-04	mg/kg/day	NA	NA	NA	4.2E-04	mg/kg/day	6.0E-01	mg/kg/day	7.0E-04
				Thallium	8.0E-02	mg/kg	1.1E-07	mg/kg/day	NA	NA	NA	3.1E-07	mg/kg/day	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	3.2E-04	mg/kg/day	5.0E-03	mg/kg/day	6.5E-02
				Zinc	3.6E+03	mg/kg	5.0E-03	mg/kg/day	NA	NA	NA	1.4E-02	mg/kg/day	3.0E-01	mg/kg/day	4.7E-02
			Exp. Route Total								2.1E-05					1.5E+00

TABLE 7.39.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Dermal	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.6E+01	mg/kg	3.4E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.9E-05	9.5E-06	mg/kg/day	3.0E-04	mg/kg/day	3.2E-02
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	NA
				Cadmium (non-water)	3.9E+01	mg/kg	2.7E-07	mg/kg/day	NA	NA	NA	7.5E-07	mg/kg/day	2.5E-05	mg/kg/day	3.0E-02
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								1.9E-05					6.2E-02
		Exposure Point Total									3.9E-05					1.5E+00
	Exposure Medium Total										3.9E-05					1.5E+00
Medium Total											3.9E-05					1.5E+00

TABLE 7.39.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Ingestion	Aluminum	1.9E+00	mg/L	3.6E-03	mg/kg/day	NA	NA	NA	1.0E-02	mg/kg/day	1.0E+00	mg/kg/day	1.0E-02
				Antimony	9.0E-04	mg/L	1.7E-06	mg/kg/day	NA	NA	NA	4.9E-06	mg/kg/day	4.0E-04	mg/kg/day	1.2E-02
				Arsenic	9.2E-04	mg/L	1.8E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.7E-06	5.0E-06	mg/kg/day	3.0E-04	mg/kg/day	1.7E-02
				Barium	7.9E-02	mg/L	1.5E-04	mg/kg/day	NA	NA	NA	4.3E-04	mg/kg/day	2.0E-01	mg/kg/day	2.1E-03
				Cadmium (water)	1.7E-03	mg/L	3.3E-06	mg/kg/day	NA	NA	NA	9.1E-06	mg/kg/day	5.0E-04	mg/kg/day	1.8E-02
				Chromium (hexavalent)	2.3E-03	mg/L	4.5E-06	mg/kg/day	5.0E-01	1/(mg/kg/day)	2.2E-06	1.2E-05	mg/kg/day	3.0E-03	mg/kg/day	4.2E-03
				Cobalt	2.0E-03	mg/L	3.9E-06	mg/kg/day	NA	NA	NA	1.1E-05	mg/kg/day	3.0E-04	mg/kg/day	3.6E-02
				Copper	6.3E-03	mg/L	1.2E-05	mg/kg/day	NA	NA	NA	3.4E-05	mg/kg/day	4.0E-02	mg/kg/day	8.5E-04
				Iron	1.8E+00	mg/L	3.5E-03	mg/kg/day	NA	NA	NA	9.8E-03	mg/kg/day	7.0E-01	mg/kg/day	1.4E-02
				Lead	6.2E-03	mg/L	1.2E-05	mg/kg/day	NA	NA	NA	3.3E-05	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	4.1E-04	mg/kg/day	NA	NA	NA	1.1E-03	mg/kg/day	2.4E-02	mg/kg/day	4.7E-02
				Mercury (HgCl)	5.2E-04	mg/L	1.0E-06	mg/kg/day	NA	NA	NA	2.8E-06	mg/kg/day	3.0E-04	mg/kg/day	9.4E-03
				Molybdenum	3.9E-03	mg/L	7.5E-06	mg/kg/day	NA	NA	NA	2.1E-05	mg/kg/day	5.0E-03	mg/kg/day	4.2E-03
				Nickel	9.5E-03	mg/L	1.8E-05	mg/kg/day	NA	NA	NA	5.1E-05	mg/kg/day	2.0E-02	mg/kg/day	2.6E-03
				Selenium	4.7E-04	mg/L	9.1E-07	mg/kg/day	NA	NA	NA	2.6E-06	mg/kg/day	5.0E-03	mg/kg/day	5.1E-04
				Silica (as SIO2)	1.5E+01	mg/L	2.9E-02	mg/kg/day	NA	NA	NA	8.2E-02	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	1.5E-06	mg/kg/day	NA	NA	NA	4.3E-06	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	4.2E-06	mg/kg/day	NA	NA	NA	1.2E-05	mg/kg/day	5.0E-03	mg/kg/day	2.4E-03
				Zinc	2.5E-01	mg/L	4.9E-04	mg/kg/day	NA	NA	NA	1.4E-03	mg/kg/day	3.0E-01	mg/kg/day	4.5E-03
			Exp. Route Total								4.9E-06					1.9E-01

TABLE 7.39.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	7.8E-04	mg/kg/day	NA	NA	NA	2.2E-03	mg/kg/day	1.0E+00	mg/kg/day	2.2E-03
				Antimony	9.0E-04	mg/L	3.7E-07	mg/kg/day	NA	NA	NA	1.0E-06	mg/kg/day	6.0E-05	mg/kg/day	1.7E-02
				Arsenic	9.2E-04	mg/L	3.8E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	5.7E-07	1.1E-06	mg/kg/day	3.0E-04	mg/kg/day	3.6E-03
				Barium	7.9E-02	mg/L	3.2E-05	mg/kg/day	NA	NA	NA	9.1E-05	mg/kg/day	1.4E-02	mg/kg/day	6.5E-03
				Cadmium (water)	1.7E-03	mg/L	7.0E-07	mg/kg/day	NA	NA	NA	1.9E-06	mg/kg/day	2.5E-05	mg/kg/day	7.8E-02
				Chromium (hexavalent)	2.3E-03	mg/L	1.9E-06	mg/kg/day	2.0E+01	1/(mg/kg/day)	3.8E-05	5.3E-06	mg/kg/day	7.5E-05	mg/kg/day	7.1E-02
				Cobalt	2.0E-03	mg/L	3.3E-07	mg/kg/day	NA	NA	NA	9.3E-07	mg/kg/day	3.0E-04	mg/kg/day	3.1E-03
				Copper	6.3E-03	mg/L	2.6E-06	mg/kg/day	NA	NA	NA	7.3E-06	mg/kg/day	4.0E-02	mg/kg/day	1.8E-04
				Iron	1.8E+00	mg/L	7.4E-04	mg/kg/day	NA	NA	NA	2.1E-03	mg/kg/day	7.0E-01	mg/kg/day	3.0E-03
				Lead	6.2E-03	mg/L	2.5E-07	mg/kg/day	NA	NA	NA	7.1E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	8.7E-05	mg/kg/day	NA	NA	NA	2.4E-04	mg/kg/day	9.6E-04	mg/kg/day	2.5E-01
				Mercury (HgCl)	5.2E-04	mg/L	2.1E-07	mg/kg/day	NA	NA	NA	6.0E-07	mg/kg/day	2.1E-05	mg/kg/day	2.9E-02
				Molybdenum	3.9E-03	mg/L	1.6E-06	mg/kg/day	NA	NA	NA	4.5E-06	mg/kg/day	5.0E-03	mg/kg/day	9.0E-04
				Nickel	9.5E-03	mg/L	7.8E-07	mg/kg/day	NA	NA	NA	2.2E-06	mg/kg/day	8.0E-04	mg/kg/day	2.7E-03
				Selenium	4.7E-04	mg/L	1.9E-07	mg/kg/day	NA	NA	NA	5.4E-07	mg/kg/day	5.0E-03	mg/kg/day	1.1E-04
				Silica (as SIO2)	1.5E+01	mg/L	6.2E-03	mg/kg/day	NA	NA	NA	1.7E-02	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	3.3E-07	mg/kg/day	NA	NA	NA	9.2E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	9.0E-07	mg/kg/day	NA	NA	NA	2.5E-06	mg/kg/day	1.3E-04	mg/kg/day	1.9E-02
				Zinc	2.5E-01	mg/L	6.2E-05	mg/kg/day	NA	NA	NA	1.7E-04	mg/kg/day	3.0E-01	mg/kg/day	5.8E-04
			Exp. Route Total								3.9E-05					4.9E-01
		Exposure Point Total									4.4E-05					6.8E-01
	Exposure Medium Total										4.4E-05					6.8E-01
Medium Total											4.4E-05					6.8E-01
Receptor Total (Sediment + Surface Water)											8E-05					2E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligram per liter

TABLE 7.39.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Exposure Scenario: Work Activities

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)
Aluminum	1.9E+00	1.0E-03	6.0	1.1E-05
Antimony	9.0E-04	1.0E-03	6.0	5.4E-09
Arsenic	9.2E-04	1.0E-03	6.0	5.5E-09
Barium	7.9E-02	1.0E-03	6.0	4.7E-07
Cadmium (water)	1.7E-03	1.0E-03	6.0	1.0E-08
Chromium (hexavalent)	2.3E-03	2.0E-03	6.0	2.8E-08
Cobalt	2.0E-03	4.0E-04	6.0	4.8E-09
Copper	6.3E-03	1.0E-03	6.0	3.8E-08
Iron	1.8E+00	1.0E-03	6.0	1.1E-05
Lead	6.2E-03	1.0E-04	6.0	3.7E-09
Manganese (non-diet)	2.1E-01	1.0E-03	6.0	1.3E-06
Mercury (HgCl)	5.2E-04	1.0E-03	6.0	3.1E-09
Molybdenum	3.9E-03	1.0E-03	6.0	2.3E-08
Nickel	9.5E-03	2.0E-04	6.0	1.1E-08
Selenium	4.7E-04	1.0E-03	6.0	2.8E-09
Silica (as SIO2)	1.5E+01	1.0E-03	6.0	9.1E-05
Thallium	8.0E-04	1.0E-03	6.0	4.8E-09
Vanadium	2.2E-03	1.0E-03	6.0	1.3E-08
Zinc	2.5E-01	6.0E-04	6.0	9.1E-07

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event =milligram per square centimeter per event
mg/L = milligram per liter

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	7.6E-04	mg/kg/day	1.0E+00	mg/kg/day	7.6E-04
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	4.0E-04	mg/kg/day	4.7E-04
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	9.5E-07	mg/kg/day	3.0E-04	mg/kg/day	3.2E-03
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	4.0E-05	mg/kg/day	2.0E-01	mg/kg/day	2.0E-04
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	2.0E-03	mg/kg/day	9.8E-05
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	2.0E-01	mg/kg/day	5.9E-06
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	3.8E-06	mg/kg/day	1.0E-03	mg/kg/day	3.8E-03
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	6.0E-06	mg/kg/day	1.5E+00	mg/kg/day	4.0E-06
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	2.5E-06	mg/kg/day	3.0E-04	mg/kg/day	8.3E-03
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-06	mg/kg/day	4.0E-02	mg/kg/day	5.9E-05
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	4.7E-03	mg/kg/day	7.0E-01	mg/kg/day	6.7E-03
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	5.2E-06	mg/kg/day	2.0E-03	mg/kg/day	2.6E-03
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	2.4E-02	mg/kg/day	4.3E-03
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	1.6E-08	mg/kg/day	3.0E-04	mg/kg/day	5.5E-05
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	9.6E-06	mg/kg/day	5.0E-03	mg/kg/day	1.9E-03
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	3.5E-06	mg/kg/day	2.0E-02	mg/kg/day	1.7E-04
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	9.3E-05	mg/kg/day	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	6.0E-07	mg/kg/day	5.0E-03	mg/kg/day	1.2E-04
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	2.1E-04	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	7.7E-07	mg/kg/day	5.0E-03	mg/kg/day	1.5E-04
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	6.0E-01	mg/kg/day	1.7E-05
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	7.7E-09	mg/kg/day	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	7.9E-06	mg/kg/day	5.0E-03	mg/kg/day	1.6E-03
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	3.0E-01	mg/kg/day	1.2E-03
			Exp. Route Total								NA					3.6E-02

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	3.0E-04	mg/kg/day	6.7E-04
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	NA
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	1.6E-08	mg/kg/day	2.5E-05	mg/kg/day	6.3E-04
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					1.3E-03
		Exposure Point Total									NA					3.7E-02
	Exposure Medium Total										NA					3.7E-02
Medium Total											NA					3.7E-02

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	1.0E+00	mg/kg/day	1.7E-04
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	7.9E-08	mg/kg/day	4.0E-04	mg/kg/day	2.0E-04
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	8.2E-08	mg/kg/day	3.0E-04	mg/kg/day	2.7E-04
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	2.0E-01	mg/kg/day	3.5E-05
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	5.0E-04	mg/kg/day	3.0E-04
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	3.0E-03	mg/kg/day	6.8E-05
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	3.0E-04	mg/kg/day	5.9E-04
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	5.6E-07	mg/kg/day	4.0E-02	mg/kg/day	1.4E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	7.0E-01	mg/kg/day	2.3E-04
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	5.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	1.9E-05	mg/kg/day	2.4E-02	mg/kg/day	7.8E-04
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	4.6E-08	mg/kg/day	3.0E-04	mg/kg/day	1.5E-04
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	3.4E-07	mg/kg/day	5.0E-03	mg/kg/day	6.9E-05
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	8.4E-07	mg/kg/day	2.0E-02	mg/kg/day	4.2E-05
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	4.2E-08	mg/kg/day	5.0E-03	mg/kg/day	8.3E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.3E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	7.1E-08	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.9E-07	mg/kg/day	5.0E-03	mg/kg/day	3.8E-05
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	2.2E-05	mg/kg/day	3.0E-01	mg/kg/day	7.4E-05
			Exp. Route Total								NA					3.0E-03

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	3.6E-05	mg/kg/day	1.0E+00	mg/kg/day	3.6E-05
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	1.7E-08	mg/kg/day	6.0E-05	mg/kg/day	2.8E-04
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	1.7E-08	mg/kg/day	3.0E-04	mg/kg/day	5.8E-05
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.5E-06	mg/kg/day	1.4E-02	mg/kg/day	1.1E-04
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	3.2E-08	mg/kg/day	2.5E-05	mg/kg/day	1.3E-03
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	8.7E-08	mg/kg/day	7.5E-05	mg/kg/day	1.2E-03
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	3.0E-04	mg/kg/day	5.1E-05
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.2E-07	mg/kg/day	4.0E-02	mg/kg/day	3.0E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	3.4E-05	mg/kg/day	7.0E-01	mg/kg/day	4.9E-05
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.2E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	4.0E-06	mg/kg/day	9.6E-04	mg/kg/day	4.1E-03
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	9.8E-09	mg/kg/day	2.1E-05	mg/kg/day	4.7E-04
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	7.3E-08	mg/kg/day	5.0E-03	mg/kg/day	1.5E-05
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	3.6E-08	mg/kg/day	8.0E-04	mg/kg/day	4.5E-05
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	8.9E-09	mg/kg/day	5.0E-03	mg/kg/day	1.8E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.1E-08	mg/kg/day	1.3E-04	mg/kg/day	3.2E-04
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	2.8E-06	mg/kg/day	3.0E-01	mg/kg/day	9.5E-06
			Exp. Route Total								NA					8.0E-03
		Exposure Point Total									NA					1.1E-02

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	2.2E-05	mg/kg/day	1.0E+00	mg/kg/day	2.2E-05
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	1.0E-08	mg/kg/day	6.0E-05	mg/kg/day	1.7E-04
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	1.1E-08	mg/kg/day	3.0E-04	mg/kg/day	3.6E-05
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	9.1E-07	mg/kg/day	1.4E-02	mg/kg/day	6.5E-05
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	2.0E-08	mg/kg/day	2.5E-05	mg/kg/day	7.8E-04
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	5.3E-08	mg/kg/day	7.5E-05	mg/kg/day	7.1E-04
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	9.3E-09	mg/kg/day	3.0E-04	mg/kg/day	3.1E-05
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	7.3E-08	mg/kg/day	4.0E-02	mg/kg/day	1.8E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	7.0E-01	mg/kg/day	3.0E-05
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	7.1E-09	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	9.6E-04	mg/kg/day	2.5E-03
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	6.0E-09	mg/kg/day	2.1E-05	mg/kg/day	2.9E-04
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	4.5E-08	mg/kg/day	5.0E-03	mg/kg/day	9.0E-06
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	2.2E-08	mg/kg/day	8.0E-04	mg/kg/day	2.8E-05
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	5.5E-09	mg/kg/day	5.0E-03	mg/kg/day	1.1E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	9.3E-09	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	2.5E-08	mg/kg/day	1.3E-04	mg/kg/day	1.9E-04
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.7E-06	mg/kg/day	3.0E-01	mg/kg/day	5.8E-06
			Exp. Route Total								NA					4.9E-03
		Exposure Point Total									NA					4.9E-03

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	5.7E-02	mg/kg/day	1.0E+00	mg/kg/day	5.7E-02
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	4.0E-04	mg/kg/day	6.7E-02
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	2.8E-05	mg/kg/day	3.0E-04	mg/kg/day	9.2E-02
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	2.4E-03	mg/kg/day	2.0E-01	mg/kg/day	1.2E-02
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	5.1E-05	mg/kg/day	5.0E-04	mg/kg/day	1.0E-01
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	6.9E-05	mg/kg/day	3.0E-03	mg/kg/day	2.3E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	4.0E-02	mg/kg/day	4.7E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.4E-02	mg/kg/day	7.0E-01	mg/kg/day	7.7E-02
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	6.3E-03	mg/kg/day	2.4E-02	mg/kg/day	2.6E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.6E-05	mg/kg/day	3.0E-04	mg/kg/day	5.2E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	5.0E-03	mg/kg/day	2.3E-02
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	2.9E-04	mg/kg/day	2.0E-02	mg/kg/day	1.4E-02
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	5.0E-03	mg/kg/day	2.8E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	4.5E-01	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	6.5E-05	mg/kg/day	5.0E-03	mg/kg/day	1.3E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	7.6E-03	mg/kg/day	3.0E-01	mg/kg/day	2.5E-02
			Exp. Route Total								NA					1.0E+00

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	1.0E+00	mg/kg/day	3.2E-04
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	6.0E-05	mg/kg/day	2.5E-03
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	3.0E-04	mg/kg/day	5.2E-04
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.3E-05	mg/kg/day	1.4E-02	mg/kg/day	9.4E-04
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	2.8E-07	mg/kg/day	2.5E-05	mg/kg/day	1.1E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	7.7E-07	mg/kg/day	7.5E-05	mg/kg/day	1.0E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	3.0E-04	mg/kg/day	4.5E-04
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.1E-06	mg/kg/day	4.0E-02	mg/kg/day	2.6E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	7.0E-01	mg/kg/day	4.3E-04
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	3.5E-05	mg/kg/day	9.6E-04	mg/kg/day	3.7E-02
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	8.7E-08	mg/kg/day	2.1E-05	mg/kg/day	4.1E-03
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	6.5E-07	mg/kg/day	5.0E-03	mg/kg/day	1.3E-04
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	3.2E-07	mg/kg/day	8.0E-04	mg/kg/day	4.0E-04
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	7.9E-08	mg/kg/day	5.0E-03	mg/kg/day	1.6E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	2.5E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	3.6E-07	mg/kg/day	1.3E-04	mg/kg/day	2.8E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	3.0E-01	mg/kg/day	8.4E-05
			Exp. Route Total								NA					7.1E-02
		Exposure Point Total									NA					1.1E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					1.1E+00
	Exposure Medium Total (Wading + Potable Use)										NA					1.1E+00
Medium Total (Swimming + Potable Use)											NA					1.1E+00
Medium Total (Wading + Potable Use)											NA					1.1E+00

TABLE 7.40.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	4.0E-04	mg/kg/day	5.1E-01
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	9.1E-02
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	2.0E-01	mg/kg/day	1.4E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	9.9E-06	mg/kg/day	2.0E-03	mg/kg/day	4.9E-03
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	3.1E-05	mg/kg/day	1.0E-03	mg/kg/day	3.1E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	2.8E-04	mg/kg/day	1.5E+00	mg/kg/day	1.9E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	3.0E-04	mg/kg/day	2.0E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	4.0E-02	mg/kg/day	1.1E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	7.0E-01	mg/kg/day	4.5E-03
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	1.6E-03	mg/kg/day	1.4E-01	mg/kg/day	1.2E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	4.2E-05	mg/kg/day	1.0E-04	mg/kg/day	4.2E-01
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	6.3E-05	mg/kg/day	2.0E-02	mg/kg/day	3.2E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	6.7E-04	mg/kg/day	5.0E-03	mg/kg/day	1.3E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	5.0E-03	mg/kg/day	2.6E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	5.8E-04	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	8.7E-03	mg/kg/day	3.0E-01	mg/kg/day	2.9E-02
			Exp. Route Total								NA					1.5E+00
		Exposure Point Total									NA					1.5E+00
	Exposure Medium Total										NA					1.5E+00
Medium Total											NA					1.5E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					3E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					3E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.40.RME SUPPLEMENT A
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Swimming

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.9E+00	1.0E-03	1.0	1.9E-06	1.0	1.9E-06	3.9E-01
Antimony	9.0E-04	1.0E-03	1.0	9.0E-10	1.0	9.0E-10	1.9E-04
Arsenic	9.2E-04	1.0E-03	1.0	9.2E-10	1.0	9.2E-10	1.9E-04
Barium	7.9E-02	1.0E-03	1.0	7.9E-08	1.0	7.9E-08	1.6E-02
Cadmium (water)	1.7E-03	1.0E-03	1.0	1.7E-09	1.0	1.7E-09	3.5E-04
Chromium (hexavalent)	2.3E-03	2.0E-03	1.0	4.6E-09	1.0	4.6E-09	9.6E-04
Cobalt	2.0E-03	4.0E-04	1.0	8.0E-10	1.0	8.0E-10	1.7E-04
Copper	6.3E-03	1.0E-03	1.0	6.3E-09	1.0	6.3E-09	1.3E-03
Iron	1.8E+00	1.0E-03	1.0	1.8E-06	1.0	1.8E-06	3.8E-01
Lead	6.2E-03	1.0E-04	1.0	6.2E-10	1.0	6.2E-10	1.3E-04
Manganese (non-diet)	2.1E-01	1.0E-03	1.0	2.1E-07	1.0	2.1E-07	4.4E-02
Mercury (HgCl)	5.2E-04	1.0E-03	1.0	5.2E-10	1.0	5.2E-10	1.1E-04
Molybdenum	3.9E-03	1.0E-03	1.0	3.9E-09	1.0	3.9E-09	8.1E-04
Nickel	9.5E-03	2.0E-04	1.0	1.9E-09	1.0	1.9E-09	4.0E-04
Selenium	4.7E-04	1.0E-03	1.0	4.7E-10	1.0	4.7E-10	9.9E-05
Silica (as SIO2)	1.5E+01	1.0E-03	1.0	1.5E-05	1.0	1.5E-05	3.2E+00
Thallium	8.0E-04	1.0E-03	1.0	8.0E-10	1.0	8.0E-10	1.7E-04
Vanadium	2.2E-03	1.0E-03	1.0	2.2E-09	1.0	2.2E-09	4.6E-04
Zinc	2.5E-01	6.0E-04	1.0	1.5E-07	1.0	1.5E-07	3.2E-02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.40.RME SUPPLEMENT B
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Wading

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	6,032	2,373
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	28	28
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.9E+00	1.0E-03	2.0	3.8E-06	2.0	3.8E-06	2.6E-01
Antimony	9.0E-04	1.0E-03	2.0	1.8E-09	2.0	1.8E-09	1.2E-04
Arsenic	9.2E-04	1.0E-03	2.0	1.8E-09	2.0	1.8E-09	1.3E-04
Barium	7.9E-02	1.0E-03	2.0	1.6E-07	2.0	1.6E-07	1.1E-02
Cadmium (water)	1.7E-03	1.0E-03	2.0	3.4E-09	2.0	3.4E-09	2.3E-04
Chromium (hexavalent)	2.3E-03	2.0E-03	2.0	9.2E-09	2.0	9.2E-09	6.4E-04
Cobalt	2.0E-03	4.0E-04	2.0	1.6E-09	2.0	1.6E-09	1.1E-04
Copper	6.3E-03	1.0E-03	2.0	1.3E-08	2.0	1.3E-08	8.7E-04
Iron	1.8E+00	1.0E-03	2.0	3.6E-06	2.0	3.6E-06	2.5E-01
Lead	6.2E-03	1.0E-04	2.0	1.2E-09	2.0	1.2E-09	8.5E-05
Manganese (non-diet)	2.1E-01	1.0E-03	2.0	4.2E-07	2.0	4.2E-07	2.9E-02
Mercury (HgCl)	5.2E-04	1.0E-03	2.0	1.0E-09	2.0	1.0E-09	7.2E-05
Molybdenum	3.9E-03	1.0E-03	2.0	7.8E-09	2.0	7.8E-09	5.4E-04
Nickel	9.5E-03	2.0E-04	2.0	3.8E-09	2.0	3.8E-09	2.6E-04
Selenium	4.7E-04	1.0E-03	2.0	9.4E-10	2.0	9.4E-10	6.5E-05
Silica (as SIO2)	1.5E+01	1.0E-03	2.0	3.0E-05	2.0	3.0E-05	2.1E+00
Thallium	8.0E-04	1.0E-03	2.0	1.6E-09	2.0	1.6E-09	1.1E-04
Vanadium	2.2E-03	1.0E-03	2.0	4.4E-09	2.0	4.4E-09	3.0E-04
Zinc	2.5E-01	6.0E-04	2.0	3.0E-07	2.0	3.0E-07	2.1E-02

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.40.RME SUPPLEMENT C
CALCULATION OF DAEVENT
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Exposure Scenario: Potable Water Use (Showering)

Exposure Factors	Parameter Code	Units	Adult	Child
Skin Surface Area Available for Contact	SA	cm^2	19,652	6,365
Event Frequency	EV	events/day	1	1
Exposure Frequency	EF	days/year	350	350
Exposure Duration	ED	years	20	6
Body Weight	BW	kg	80	15

Chemical of Potential Concern	Groundwater Concentration (CW) (mg/L)	Permeability Coefficient (Kp) (cm/hr)	Duration of Event (t_{event}) (hr/event)	DA_{event} (mg/cm^2-event)	Duration of Event (t_{event}) (hr)	DA_{event} (mg/cm^2-event)	DA_{event}-Adj (mg/kg)
Aluminum	1.9E+00	1.0E-03	0.71	1.3E-06	0.54	1.0E-06	3.2E+00
Antimony	9.0E-04	1.0E-03	0.71	6.4E-10	0.54	4.9E-10	1.5E-03
Arsenic	9.2E-04	1.0E-03	0.71	6.6E-10	0.54	5.0E-10	1.6E-03
Barium	7.9E-02	1.0E-03	0.71	5.6E-08	0.54	4.2E-08	1.3E-01
Cadmium (water)	1.7E-03	1.0E-03	0.71	1.2E-09	0.54	9.1E-10	2.9E-03
Chromium (hexavalent)	2.3E-03	2.0E-03	0.71	3.3E-09	0.54	2.5E-09	7.9E-03
Cobalt	2.0E-03	4.0E-04	0.71	5.7E-10	0.54	4.3E-10	1.4E-03
Copper	6.3E-03	1.0E-03	0.71	4.5E-09	0.54	3.4E-09	1.1E-02
Iron	1.8E+00	1.0E-03	0.71	1.3E-06	0.54	9.8E-07	3.1E+00
Lead	6.2E-03	1.0E-04	0.71	4.4E-10	0.54	3.3E-10	1.1E-03
Manganese (non-diet)	2.1E-01	1.0E-03	0.71	1.5E-07	0.54	1.1E-07	3.6E-01
Mercury (HgCl)	5.2E-04	1.0E-03	0.71	3.7E-10	0.54	2.8E-10	8.9E-04
Molybdenum	3.9E-03	1.0E-03	0.71	2.8E-09	0.54	2.1E-09	6.6E-03
Nickel	9.5E-03	2.0E-04	0.71	1.4E-09	0.54	1.0E-09	3.2E-03
Selenium	4.7E-04	1.0E-03	0.71	3.4E-10	0.54	2.6E-10	8.0E-04
Silica (as SIO2)	1.5E+01	1.0E-03	0.71	1.1E-05	0.54	8.2E-06	2.6E+01
Thallium	8.0E-04	1.0E-03	0.71	5.7E-10	0.54	4.3E-10	1.4E-03
Vanadium	2.2E-03	1.0E-03	0.71	1.5E-09	0.54	1.2E-09	3.7E-03
Zinc	2.5E-01	6.0E-04	0.71	1.1E-07	0.54	8.2E-08	2.6E-01

Equations:

$$DA_{event} = Kp \times CW \times t_{event} \times 0.001\ L/cm^3$$

$$DA_{event}\text{-}Adj = (DA_{event}\text{-}A \times SA\text{-}A \times EV\text{-}A \times EF\text{-}A \times ED\text{-}A) / BW\text{-}A + (DA_{event}\text{-}C \times SA\text{-}C \times EV\text{-}C \times EF\text{-}C \times ED\text{-}C) / BW\text{-}C$$

Notes:
Values for permeability constant (Kp) are from EPA Regional Screening Level Parameter Table (2019)
cm/hr = centimeter per hour
hr = hour
L/cm^3 = liter per cubic centimeter
mg/cm^2-event = milligram per square centimeter per event
µg/L = microgram per liter
mg/kg = milligram per kilogram

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	8.2E-03	mg/kg/day	1.0E+00	mg/kg/day	8.2E-03
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	2.0E-06	mg/kg/day	4.0E-04	mg/kg/day	5.0E-03
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	1.0E-05	mg/kg/day	3.0E-04	mg/kg/day	3.4E-02
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	4.3E-04	mg/kg/day	2.0E-01	mg/kg/day	2.2E-03
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	2.1E-06	mg/kg/day	2.0E-03	mg/kg/day	1.0E-03
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-05	mg/kg/day	2.0E-01	mg/kg/day	6.2E-05
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	4.0E-05	mg/kg/day	1.0E-03	mg/kg/day	4.0E-02
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	6.4E-05	mg/kg/day	1.5E+00	mg/kg/day	4.3E-05
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	2.7E-05	mg/kg/day	3.0E-04	mg/kg/day	8.9E-02
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	2.5E-05	mg/kg/day	4.0E-02	mg/kg/day	6.2E-04
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	5.0E-02	mg/kg/day	7.0E-01	mg/kg/day	7.2E-02
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	5.6E-05	mg/kg/day	2.0E-03	mg/kg/day	2.8E-02
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	2.4E-02	mg/kg/day	4.6E-02
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	1.7E-07	mg/kg/day	3.0E-04	mg/kg/day	5.8E-04
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	5.0E-03	mg/kg/day	2.0E-02
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	3.7E-05	mg/kg/day	2.0E-02	mg/kg/day	1.9E-03
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	9.9E-04	mg/kg/day	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	6.4E-06	mg/kg/day	5.0E-03	mg/kg/day	1.3E-03
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	2.3E-03	mg/kg/day	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	8.2E-06	mg/kg/day	5.0E-03	mg/kg/day	1.6E-03
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	6.0E-01	mg/kg/day	1.8E-04
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	8.2E-08	mg/kg/day	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	8.5E-05	mg/kg/day	5.0E-03	mg/kg/day	1.7E-02
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	3.7E-03	mg/kg/day	3.0E-01	mg/kg/day	1.2E-02
			Exp. Route Total								NA					3.8E-01

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.0E+00	mg/kg/day	NA
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-05	mg/kg/day	NA
				Arsenic	1.6E+01	mg/kg	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	3.0E-04	mg/kg/day	4.0E-03
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-02	mg/kg/day	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.4E-05	mg/kg/day	NA
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-01	mg/kg/day	NA
				Cadmium (non-water)	3.9E+01	mg/kg	NA	NA	NA	NA	NA	9.5E-08	mg/kg/day	2.5E-05	mg/kg/day	3.8E-03
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-02	mg/kg/day	NA
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-04	mg/kg/day	NA
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	4.0E-02	mg/kg/day	NA
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	7.0E-01	mg/kg/day	NA
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-03	mg/kg/day	NA
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	9.6E-04	mg/kg/day	NA
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.1E-05	mg/kg/day	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	8.0E-04	mg/kg/day	NA
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	5.0E-03	mg/kg/day	NA
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	2.0E-04	mg/kg/day	NA
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	6.0E-01	mg/kg/day	NA
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	NA
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	3.0E-01	mg/kg/day	NA
			Exp. Route Total								NA					7.8E-03
		Exposure Point Total									NA					3.9E-01
	Exposure Medium Total										NA					3.9E-01
Medium Total											NA					3.9E-01

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	1.2E-03	mg/kg/day	1.0E+00	mg/kg/day	1.2E-03
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	5.5E-07	mg/kg/day	4.0E-04	mg/kg/day	1.4E-03
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	5.7E-07	mg/kg/day	3.0E-04	mg/kg/day	1.9E-03
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	4.8E-05	mg/kg/day	2.0E-01	mg/kg/day	2.4E-04
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	5.0E-04	mg/kg/day	2.1E-03
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	3.0E-03	mg/kg/day	4.7E-04
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg/day	3.0E-04	mg/kg/day	4.1E-03
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	3.9E-06	mg/kg/day	4.0E-02	mg/kg/day	9.7E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	7.0E-01	mg/kg/day	1.6E-03
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	3.8E-06	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	1.3E-04	mg/kg/day	2.4E-02	mg/kg/day	5.4E-03
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	3.2E-07	mg/kg/day	3.0E-04	mg/kg/day	1.1E-03
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	2.4E-06	mg/kg/day	5.0E-03	mg/kg/day	4.8E-04
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	5.8E-06	mg/kg/day	2.0E-02	mg/kg/day	2.9E-04
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	2.9E-07	mg/kg/day	5.0E-03	mg/kg/day	5.8E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	9.3E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	4.9E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.3E-06	mg/kg/day	5.0E-03	mg/kg/day	2.7E-04
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.5E-04	mg/kg/day	3.0E-01	mg/kg/day	5.2E-04
			Exp. Route Total								NA					2.1E-02

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	6.2E-05	mg/kg/day	1.0E+00	mg/kg/day	6.2E-05
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	2.9E-08	mg/kg/day	6.0E-05	mg/kg/day	4.9E-04
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	3.0E-08	mg/kg/day	3.0E-04	mg/kg/day	1.0E-04
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	2.6E-06	mg/kg/day	1.4E-02	mg/kg/day	1.8E-04
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	5.5E-08	mg/kg/day	2.5E-05	mg/kg/day	2.2E-03
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	7.5E-05	mg/kg/day	2.0E-03
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	2.6E-08	mg/kg/day	3.0E-04	mg/kg/day	8.7E-05
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	2.1E-07	mg/kg/day	4.0E-02	mg/kg/day	5.1E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	5.9E-05	mg/kg/day	7.0E-01	mg/kg/day	8.4E-05
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	2.0E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	6.9E-06	mg/kg/day	9.6E-04	mg/kg/day	7.2E-03
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.7E-08	mg/kg/day	2.1E-05	mg/kg/day	8.1E-04
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	1.3E-07	mg/kg/day	5.0E-03	mg/kg/day	2.5E-05
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	6.2E-08	mg/kg/day	8.0E-04	mg/kg/day	7.7E-05
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	5.0E-03	mg/kg/day	3.1E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	4.9E-04	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	2.6E-08	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	7.1E-08	mg/kg/day	1.3E-04	mg/kg/day	5.5E-04
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	4.9E-06	mg/kg/day	3.0E-01	mg/kg/day	1.6E-05
			Exp. Route Total								NA					1.4E-02
		Exposure Point Total									NA					3.5E-02

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	1.0E+00	mg/kg/day	4.6E-05
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	2.2E-08	mg/kg/day	6.0E-05	mg/kg/day	3.6E-04
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	2.2E-08	mg/kg/day	3.0E-04	mg/kg/day	7.5E-05
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.9E-06	mg/kg/day	1.4E-02	mg/kg/day	1.4E-04
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	4.1E-08	mg/kg/day	2.5E-05	mg/kg/day	1.6E-03
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	7.5E-05	mg/kg/day	1.5E-03
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	2.0E-08	mg/kg/day	3.0E-04	mg/kg/day	6.5E-05
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.5E-07	mg/kg/day	4.0E-02	mg/kg/day	3.8E-06
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	4.4E-05	mg/kg/day	7.0E-01	mg/kg/day	6.3E-05
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.5E-08	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	5.1E-06	mg/kg/day	9.6E-04	mg/kg/day	5.3E-03
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.3E-08	mg/kg/day	2.1E-05	mg/kg/day	6.0E-04
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	9.5E-08	mg/kg/day	5.0E-03	mg/kg/day	1.9E-05
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	4.6E-08	mg/kg/day	8.0E-04	mg/kg/day	5.8E-05
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.1E-08	mg/kg/day	5.0E-03	mg/kg/day	2.3E-06
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.7E-04	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.9E-08	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	5.3E-08	mg/kg/day	1.3E-04	mg/kg/day	4.1E-04
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	3.7E-06	mg/kg/day	3.0E-01	mg/kg/day	1.2E-05
			Exp. Route Total								NA					1.0E-02
		Exposure Point Total									NA					1.0E-02

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	9.4E-02	mg/kg/day	1.0E+00	mg/kg/day	9.4E-02
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	4.5E-05	mg/kg/day	4.0E-04	mg/kg/day	1.1E-01
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	3.0E-04	mg/kg/day	1.5E-01
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	3.9E-03	mg/kg/day	2.0E-01	mg/kg/day	2.0E-02
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	8.4E-05	mg/kg/day	5.0E-04	mg/kg/day	1.7E-01
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg/day	3.0E-03	mg/kg/day	3.8E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg/day	3.0E-04	mg/kg/day	3.3E-01
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	3.2E-04	mg/kg/day	4.0E-02	mg/kg/day	7.9E-03
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	9.0E-02	mg/kg/day	7.0E-01	mg/kg/day	1.3E-01
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	3.1E-04	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	1.1E-02	mg/kg/day	2.4E-02	mg/kg/day	4.4E-01
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	3.0E-04	mg/kg/day	8.6E-02
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	1.9E-04	mg/kg/day	5.0E-03	mg/kg/day	3.9E-02
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	4.7E-04	mg/kg/day	2.0E-02	mg/kg/day	2.4E-02
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	2.4E-05	mg/kg/day	5.0E-03	mg/kg/day	4.7E-03
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	7.5E-01	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	4.0E-05	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	5.0E-03	mg/kg/day	2.2E-02
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	1.3E-02	mg/kg/day	3.0E-01	mg/kg/day	4.2E-02
			Exp. Route Total								NA					1.7E+00

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	NA	NA	NA	NA	NA	4.2E-04	mg/kg/day	1.0E+00	mg/kg/day	4.2E-04
				Antimony	9.0E-04	mg/L	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	6.0E-05	mg/kg/day	3.3E-03
				Arsenic	9.2E-04	mg/L	NA	NA	NA	NA	NA	2.0E-07	mg/kg/day	3.0E-04	mg/kg/day	6.8E-04
				Barium	7.9E-02	mg/L	NA	NA	NA	NA	NA	1.7E-05	mg/kg/day	1.4E-02	mg/kg/day	1.2E-03
				Cadmium (water)	1.7E-03	mg/L	NA	NA	NA	NA	NA	3.7E-07	mg/kg/day	2.5E-05	mg/kg/day	1.5E-02
				Chromium (hexavalent)	2.3E-03	mg/L	NA	NA	NA	NA	NA	1.0E-06	mg/kg/day	7.5E-05	mg/kg/day	1.4E-02
				Cobalt	2.0E-03	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	3.0E-04	mg/kg/day	5.9E-04
				Copper	6.3E-03	mg/L	NA	NA	NA	NA	NA	1.4E-06	mg/kg/day	4.0E-02	mg/kg/day	3.5E-05
				Iron	1.8E+00	mg/L	NA	NA	NA	NA	NA	4.0E-04	mg/kg/day	7.0E-01	mg/kg/day	5.7E-04
				Lead	6.2E-03	mg/L	NA	NA	NA	NA	NA	1.4E-07	mg/kg/day	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	NA	NA	NA	NA	NA	4.6E-05	mg/kg/day	9.6E-04	mg/kg/day	4.8E-02
				Mercury (HgCl)	5.2E-04	mg/L	NA	NA	NA	NA	NA	1.1E-07	mg/kg/day	2.1E-05	mg/kg/day	5.4E-03
				Molybdenum	3.9E-03	mg/L	NA	NA	NA	NA	NA	8.6E-07	mg/kg/day	5.0E-03	mg/kg/day	1.7E-04
				Nickel	9.5E-03	mg/L	NA	NA	NA	NA	NA	4.2E-07	mg/kg/day	8.0E-04	mg/kg/day	5.2E-04
				Selenium	4.7E-04	mg/L	NA	NA	NA	NA	NA	1.0E-07	mg/kg/day	5.0E-03	mg/kg/day	2.1E-05
				Silica (as SIO2)	1.5E+01	mg/L	NA	NA	NA	NA	NA	3.3E-03	mg/kg/day	NA	NA	NA
				Thallium	8.0E-04	mg/L	NA	NA	NA	NA	NA	1.8E-07	mg/kg/day	NA	NA	NA
				Vanadium	2.2E-03	mg/L	NA	NA	NA	NA	NA	4.8E-07	mg/kg/day	1.3E-04	mg/kg/day	3.7E-03
				Zinc	2.5E-01	mg/L	NA	NA	NA	NA	NA	3.3E-05	mg/kg/day	3.0E-01	mg/kg/day	1.1E-04
			Exp. Route Total								NA					9.3E-02
		Exposure Point Total									NA					1.8E+00
	Exposure Medium Total (Swimming + Potable Use)										NA					1.8E+00
	Exposure Medium Total (Wading + Potable Use)										NA					1.8E+00
Medium Total (Swimming + Potable Use)											NA					1.8E+00
Medium Total (Wading + Potable Use)											NA					1.8E+00

TABLE 7.41.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	NA	NA	NA	NA	NA	3.1E-03	mg/kg/day	1.0E+00	mg/kg/day	3.1E-03
				Antimony	2.4E-01	mg/kg	NA	NA	NA	NA	NA	5.4E-04	mg/kg/day	4.0E-04	mg/kg/day	1.4E+00
				Arsenic	3.3E-02	mg/kg	NA	NA	NA	NA	NA	7.3E-05	mg/kg/day	3.0E-04	mg/kg/day	2.4E-01
				Barium	3.3E-01	mg/kg	NA	NA	NA	NA	NA	7.4E-04	mg/kg/day	2.0E-01	mg/kg/day	3.7E-03
				Beryllium	1.2E-02	mg/kg	NA	NA	NA	NA	NA	2.6E-05	mg/kg/day	2.0E-03	mg/kg/day	1.3E-02
				Cadmium (non-water)	3.7E-02	mg/kg	NA	NA	NA	NA	NA	8.3E-05	mg/kg/day	1.0E-03	mg/kg/day	8.3E-02
				Chromium (trivalent)	3.4E-01	mg/kg	NA	NA	NA	NA	NA	7.5E-04	mg/kg/day	1.5E+00	mg/kg/day	5.0E-04
				Cobalt	7.0E-02	mg/kg	NA	NA	NA	NA	NA	1.6E-04	mg/kg/day	3.0E-04	mg/kg/day	5.2E-01
				Copper	5.0E-01	mg/kg	NA	NA	NA	NA	NA	1.1E-03	mg/kg/day	4.0E-02	mg/kg/day	2.8E-02
				Iron	3.8E+00	mg/kg	NA	NA	NA	NA	NA	8.4E-03	mg/kg/day	7.0E-01	mg/kg/day	1.2E-02
				Lead	1.0E-01	mg/kg	NA	NA	NA	NA	NA	2.2E-04	mg/kg/day	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	NA	NA	NA	NA	NA	4.4E-03	mg/kg/day	1.4E-01	mg/kg/day	3.1E-02
				Mercury (MeHg)	5.0E-02	mg/kg	NA	NA	NA	NA	NA	1.1E-04	mg/kg/day	1.0E-04	mg/kg/day	1.1E+00
				Nickel	7.6E-02	mg/kg	NA	NA	NA	NA	NA	1.7E-04	mg/kg/day	2.0E-02	mg/kg/day	8.4E-03
				Selenium	8.0E-01	mg/kg	NA	NA	NA	NA	NA	1.8E-03	mg/kg/day	5.0E-03	mg/kg/day	3.6E-01
				Silver	1.6E-01	mg/kg	NA	NA	NA	NA	NA	3.5E-04	mg/kg/day	5.0E-03	mg/kg/day	7.0E-02
				Thallium	6.9E-01	mg/kg	NA	NA	NA	NA	NA	1.5E-03	mg/kg/day	NA	NA	NA
				Zinc	1.0E+01	mg/kg	NA	NA	NA	NA	NA	2.3E-02	mg/kg/day	3.0E-01	mg/kg/day	7.8E-02
			Exp. Route Total								NA					3.9E+00
		Exposure Point Total									NA					3.9E+00
	Exposure Medium Total										NA					3.9E+00
Medium Total											NA					3.9E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)											NA					6E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)											NA					6E+00

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Ingestion	Aluminum	8.0E+03	mg/kg	9.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.0E+00	mg/kg	2.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.6E+01	mg/kg	1.1E-06	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.7E-06	NA	NA	NA	NA	NA
				Barium	4.2E+02	mg/kg	4.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	2.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Boron	1.2E+01	mg/kg	1.4E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.9E+01	mg/kg	4.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	6.2E+01	mg/kg	7.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.6E+01	mg/kg	3.0E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.4E+01	mg/kg	2.8E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	4.9E+04	mg/kg	5.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.5E+02	mg/kg	1.7E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	6.3E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.1E+03	mg/kg	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.7E-01	mg/kg	2.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.6E+01	mg/kg	4.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	9.7E+02	mg/kg	1.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	7.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	2.2E+03	mg/kg	2.6E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	9.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	1.1E+02	mg/kg	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-02	mg/kg	9.2E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	9.5E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.6E+03	mg/kg	4.1E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.7E-06					NA

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment (Rivers & Creeks) (cont.)	Sediment (Rivers & Creeks) (cont.)	Sediment (0 to 12-inch deep) (cont.)	Dermal	Aluminum	8.0E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	1.6E+01	mg/kg	1.6E-07	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.4E-07	NA	NA	NA	NA	NA
				Barium	4.2E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	2.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Boron	1.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.9E+01	mg/kg	1.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	6.2E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	2.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	2.4E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	4.9E+04	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.5E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Lithium	5.5E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	1.1E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	1.7E-01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	1.0E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	3.6E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Phosphorus	9.7E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	6.3E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	2.2E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	8.0E+00	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Strontium	1.1E+02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-02	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	8.3E+01	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	3.6E+03	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.4E-07					NA
		Exposure Point Total									1.9E-06					NA
	Exposure Medium Total										1.9E-06					NA
Medium Total											1.9E-06					NA

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Aluminum	1.9E+00	mg/L	1.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	7.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	7.2E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.1E-07	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	6.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	1.8E-07	mg/kg/day	5.0E-01	1/(mg/kg/day)	3.8E-07	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	1.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	4.9E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	4.8E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	4.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	3.0E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	7.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	3.7E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	6.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.7E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	2.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								4.9E-07					NA

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Swimming (cont.)	Dermal	Aluminum	1.9E+00	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	7.4E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	7.6E-09	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.1E-08	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	6.4E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	1.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	3.8E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	2.4E-06	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	6.6E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	5.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.5E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	5.0E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	1.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	4.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	3.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	1.6E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	3.9E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	6.5E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.8E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	1.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.4E-06					NA
		Exposure Point Total									2.9E-06					NA

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Dermal	Aluminum	1.9E+00	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	4.8E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	5.0E-09	mg/kg/day	1.5E+00	1/(mg/kg/day)	7.5E-09	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	4.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	9.1E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	2.5E-08	mg/kg/day	2.0E+01	1/(mg/kg/day)	1.6E-06	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	4.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	3.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	9.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	3.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	1.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	2.8E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	2.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	1.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	2.5E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	8.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	4.3E-09	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.2E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	8.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.6E-06					NA
		Exposure Point Total									1.6E-06					NA

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Ingestion	Aluminum	1.9E+00	mg/L	2.4E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	1.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	1.2E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	1.8E-05	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	1.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	3.0E-05	mg/kg/day	5.0E-01	1/(mg/kg/day)	4.6E-05	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	2.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	8.1E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	2.3E-02	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	7.9E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	2.7E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	6.7E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	5.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	6.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.9E-01	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	2.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	3.2E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								6.4E-05					NA

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use) (cont.)	Dermal	Aluminum	1.9E+00	mg/L	1.3E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	9.0E-04	mg/L	6.0E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	9.2E-04	mg/L	6.2E-08	mg/kg/day	1.5E+00	1/(mg/kg/day)	9.2E-08	NA	NA	NA	NA	NA
				Barium	7.9E-02	mg/L	5.2E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (water)	1.7E-03	mg/L	1.1E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (hexavalent)	2.3E-03	mg/L	3.1E-07	mg/kg/day	2.0E+01	1/(mg/kg/day)	1.9E-05	NA	NA	NA	NA	NA
				Cobalt	2.0E-03	mg/L	5.4E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	6.3E-03	mg/L	4.2E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	1.8E+00	mg/L	1.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	6.2E-03	mg/L	4.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (non-diet)	2.1E-01	mg/L	1.4E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (HgCl)	5.2E-04	mg/L	3.5E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Molybdenum	3.9E-03	mg/L	2.6E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	9.5E-03	mg/L	1.3E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	4.7E-04	mg/L	3.1E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silica (as SIO2)	1.5E+01	mg/L	1.0E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	8.0E-04	mg/L	5.3E-08	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Vanadium	2.2E-03	mg/L	1.5E-07	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	2.5E-01	mg/L	1.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								1.9E-05					NA
		Exposure Point Total									8.3E-05					NA
	Exposure Medium Total (Swimming + Potable Use)										8.6E-05					NA
	Exposure Medium Total (Wading + Potable Use)										8.5E-05					NA
Medium Total (Swimming + Potable Use)											8.6E-05					NA
Medium Total (Wading + Potable Use)											8.5E-05					NA

TABLE 7.42.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Ingestion	Aluminum	1.4E+00	mg/kg	5.9E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Antimony	2.4E-01	mg/kg	1.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Arsenic	3.3E-02	mg/kg	1.4E-05	mg/kg/day	1.5E+00	1/(mg/kg/day)	2.1E-05	NA	NA	NA	NA	NA
				Barium	3.3E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Beryllium	1.2E-02	mg/kg	5.1E-06	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cadmium (non-water)	3.7E-02	mg/kg	1.6E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Chromium (trivalent)	3.4E-01	mg/kg	1.4E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Cobalt	7.0E-02	mg/kg	3.0E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Copper	5.0E-01	mg/kg	2.2E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Iron	3.8E+00	mg/kg	1.6E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Lead	1.0E-01	mg/kg	4.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Manganese (diet)	2.0E+00	mg/kg	8.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Mercury (MeHg)	5.0E-02	mg/kg	2.2E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Nickel	7.6E-02	mg/kg	3.3E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Selenium	8.0E-01	mg/kg	3.5E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Silver	1.6E-01	mg/kg	6.8E-05	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Thallium	6.9E-01	mg/kg	3.0E-04	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
				Zinc	1.0E+01	mg/kg	4.5E-03	mg/kg/day	NA	NA	NA	NA	NA	NA	NA	NA
			Exp. Route Total								2.1E-05					NA
		Exposure Point Total									2.1E-05					NA
	Exposure Medium Total										2.1E-05					NA
Medium Total											2.1E-05					NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)											1E-04					NA
Receptor Total (Sediment + Wading + Potable Use + Fish)											1E-04					NA

Notes:
CSF = Cancer slope factor
EPC = Exposure point concentration
NA = Not applicable/Not available
RfC = Reference concentration
RfD = Reference dose
µg/L = microgram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day
mg/L = milligrams per liter

TABLE 7.42.RME SUPPLEMENT A

CALCULATION OF CHEMICAL CANCER RISKS FOR COPC WITH MUTAGENIC MODE OF ACTION

REASONABLE MAXIMUM EXPOSURE

Lower Spring River Watershed

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations											
							Intake					CSF/Unit Risk						
					Value	Units	Value				Units	Value				Units	Cancer Risk (3)	
							0-2 yrs	2-6 yrs	6-16 yrs	16-26 yrs		0-2 yrs (ADAF=10)	2-6 yrs (ADAF=3)	6-16 yrs (ADAF=3)	16-26 yrs (ADAF=1)			
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Ingestion	Chromium (hexavalent)	2.3E-03	mg/L	4.1E-08	8.1E-08	2.9E-08	2.9E-08	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	3.8E-07	
			Dermal	Chromium (hexavalent)	2.3E-03	mg/L	4.3E-09	8.6E-09	1.2E-08	1.2E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	2.4E-06	
		Surface Water (Rivers & Creeks) Wading	Dermal	Chromium (hexavalent)	2.3E-03	mg/L	3.2E-09	6.4E-09	7.6E-09	7.6E-09	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	1.6E-06	
		Surface Water (Potable Use)	Ingestion	Chromium (hexavalent)	2.3E-03	mg/L	3.3E-06	6.6E-06	9.9E-06	9.9E-06	mg/kg-day	5.0E+00	1.5E+00	1.5E+00	5.0E-01	1/(mg/kg-day)	4.6E-05	
			Dermal	Chromium (hexavalent)	2.3E-03	mg/L	3.8E-08	7.6E-08	8.4E-08	8.4E-08	mg/kg-day	2.0E+02	6.0E+01	6.0E+01	2.0E+01	1/(mg/kg-day)	1.9E-05	

Notes:
ADAF = Age-dependent adjustment factor
bgs = below ground surface
CSF = Cancer slope factor
EPC = Exposure point concentration
mg/L = milligram per liter
mg/kg = milligram per kilogram
mg/kg/day = milligram per kilogram per day

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	5E-02	NA	NA	5E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	NA	4E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	3E-02	1E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	NA	1E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	1E-01	7E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	6E-02	NA	NA	6E-02
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	8E-03	NA	NA	8E-03
			Nickel	NA	NA	NA	NA	Whole Body	7E-03	NA	NA	7E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-03	NA	NA	7E-03
			Silver	NA	NA	NA	NA	Dermal	5E-04	NA	NA	5E-04
			Strontium	NA	NA	NA	NA	Musculoskeletal	6E-04	NA	NA	6E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	1E-01	3E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+00	NA	1E-01	3E+00
Medium Total				NA	NA	NA	NA		3E+00	NA	1E-01	3E+00

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	1E-03	6E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	5E-02	9E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	7E-02	NA	1E-02	8E-02
			Barium	NA	NA	NA	NA	Urinary	2E-03	NA	7E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-01	NA	2E+00	3E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	6E-03	NA	1E-01	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	1E-02	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	5E-04	3E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	2E-03	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	1E+00	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	7E-03	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-04	NA	1E-04	8E-04
			Vanadium	NA	NA	NA	NA	Dermal	3E-03	NA	2E-02	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	2E-02	2E-01
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	3E+00	5E+00
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	3E-02	NA	1E-04	3E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	7E-03	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-01	NA	2E-03	4E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	1E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	3E+00	NA	3E-01	3E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	3E-02	NA	1E-02	5E-02
			Cobalt	NA	NA	NA	NA	Endocrine	9E-01	NA	2E-03	9E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	7E-05	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	3E-04	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E+00	NA	1E-01	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	9E-04	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-03	NA	2E-05	4E-03
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	3E-03	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-01	NA	3E-03	8E-01
		Exposure Point Total		NA	NA	NA	NA		6E+00	NA	5E-01	7E+00

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	2E-04	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-02	NA	1E-02	9E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	3E-03	2E-01
			Barium	NA	NA	NA	NA	Urinary	5E-03	NA	1E-03	6E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E+00	NA	4E-01	2E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	1E-02	NA	2E-02	3E-02
			Cobalt	NA	NA	NA	NA	Endocrine	4E-01	NA	3E-03	4E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	1E-04	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	4E-04	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-01	NA	2E-01	6E-01
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	1E-03	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-03	NA	3E-05	1E-03
			Vanadium	NA	NA	NA	NA	Dermal	6E-03	NA	5E-03	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	4E-03	3E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	7E-01	3E+00
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	1E+00	NA	1E+00
			Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	1E+00	NA	1E+00
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E+01	NA	3E+01
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	2E+00	NA	2E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	9E+00	NA	9E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	9E+01	NA	9E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	2E-04	NA	2E-04
			Vanadium	NA	NA	NA	NA	Respiratory	NA	2E-01	NA	2E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	1E+02	NA	1E+02
	Exposure Medium Total			NA	NA	NA	NA		1E+01	1E+02	5E+00	1E+02
Medium Total				NA	NA	NA	NA		1E+01	1E+02	5E+00	1E+02

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-03	NA	NA	7E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	NA	7E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	8E-02	NA	NA	8E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	NA	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	NA	6E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	NA	8E-01
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-02	NA	NA	5E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-01	NA	NA	7E-01
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		7E+00	NA	NA	7E+00

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-02	NA	NA	6E-02
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-02	NA	NA	6E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	NA	5E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-03	NA	NA	2E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-01	NA	NA	6E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	NA	1E+01

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-01	NA	NA	7E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	NA	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	3E-03	NA	NA	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E+01	NA	NA	2E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+01	NA	NA	2E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Vanadium	NA	NA	NA	NA	Dermal	9E-01	NA	NA	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-04	7E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	7E-03	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	7E-03	1E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		1E+02	1E+02	5E+00	3E+02

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.1	**2**	**2**
Total Dermal HI Across Media =	0.2	**2**	**4**
Total Developmental HI Across Media =	NA	**2**	**2**
Total Endocrine HI Across Media =	0.2	1	**24**
Total Gastrointestinal HI Across Media =	0.2	0.1	**18**
Total Hematologic HI Across Media =	**2**	**2**	**15**
Total Hepatic HI Across Media =	NA	0.0002	NA
Total Immune HI Across Media =	**2**	1	**10**
Total Musculoskeletal HI Across Media =	0.0006	NA	NA
Total Nervous HI Across Media =	0.2	**96**	**12**
Total Not specified HI Across Media =	0.06	0.2	0.004
Total Reproductive HI Across Media =	NA	1	NA
Total Respiratory HI Across Media =	NA	**14**	NA
Total Urinary HI Across Media =	0.7	**34**	**29**
Total Whole Body HI Across Media =	0.05	0.4	**4**

	Total
Total Cardiovascular HI Across Media =	**4**
Total Dermal HI Across Media =	**7**
Total Developmental HI Across Media =	**4**
Total Endocrine HI Across Media =	**26**
Total Gastrointestinal HI Across Media =	**18**
Total Hematologic HI Across Media =	**18**
Total Hepatic HI Across Media =	0.0002
Total Immune HI Across Media =	**13**
Total Musculoskeletal HI Across Media =	0.0006
Total Nervous HI Across Media =	**108**
Total Not specified HI Across Media =	0.3
Total Reproductive HI Across Media =	1
Total Respiratory HI Across Media =	**14**
Total Urinary HI Across Media =	**64**
Total Whole Body HI Across Media =	**4**

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	NA	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	5E-01	NA	4E-02	6E-01
			Barium	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+00	NA	2E-01	3E+00
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-04	NA	NA	8E-04
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	NA	1E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	3E-01	NA	NA	3E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-01	NA	NA	6E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	NA	3E-02
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-02	NA	NA	3E-02
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	NA	2E-03
			Strontium	NA	NA	NA	NA	Musculoskeletal	3E-03	NA	NA	3E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-01	NA	NA	3E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E+00	NA	NA	8E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	2E-01	2E+01
	Exposure Medium Total			NA	NA	NA	NA		2E+01	NA	2E-01	2E+01
Medium Total				NA	NA	NA	NA		2E+01	NA	2E-01	2E+01

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	1E-03	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	6E-02	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	2E-02	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	8E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E+00	5E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	3E-02	NA	1E-01	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	8E-01	NA	2E-02	8E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	6E-04	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	2E-03	4E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	8E-01	NA	1E+00	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	8E-03	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	2E-04	3E-03
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	3E-02	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	2E-02	7E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	4E+00	9E+00
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	4E-02	NA	2E-04	4E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	3E-01	NA	8E-03	3E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	5E-01	NA	2E-03	5E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E+00	NA	4E-01	4E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	5E-02	NA	2E-02	6E-02
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	2E-03	1E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	8E-05	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-02	NA	3E-04	7E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E+00	NA	2E-01	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	5E-02	NA	1E-03	5E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	2E-05	5E-03
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	4E-03	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	3E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		9E+00	NA	6E-01	1E+01

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	5E-02	NA	3E-04	5E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-01	NA	2E-02	4E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	7E-01	NA	4E-03	7E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	2E-03	3E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E+00	NA	7E-01	6E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	6E-02	NA	3E-02	9E-02
			Cobalt	NA	NA	NA	NA	Endocrine	2E+00	NA	4E-03	2E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	2E-04	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	6E-04	9E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E+00	NA	3E-01	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	6E-02	NA	2E-03	6E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-03	NA	4E-05	7E-03
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	7E-03	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	6E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		1E+01	NA	1E+00	1E+01
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	1E+00	NA	1E+00
			Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	1E+00	NA	1E+00
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E+01	NA	3E+01
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	2E+00	NA	2E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	9E+00	NA	9E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	9E+01	NA	9E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	2E-04	NA	2E-04
			Vanadium	NA	NA	NA	NA	Respiratory	NA	2E-01	NA	2E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	1E+02	NA	1E+02
	Exposure Medium Total			NA	NA	NA	NA		3E+01	1E+02	5E+00	2E+02
Medium Total				NA	NA	NA	NA		3E+01	1E+02	5E+00	2E+02

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-01	NA	NA	5E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	9E+00	NA	NA	9E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E+00	NA	NA	2E+00
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	NA	2E+01

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	NA	9E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	6E-03	NA	NA	6E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+01	NA	NA	3E+01

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E+00	NA	NA	4E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	NA	9E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-03	NA	NA	8E-03
			Cobalt	NA	NA	NA	NA	Endocrine	5E+01	NA	NA	5E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+01	NA	NA	4E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E+01	NA	NA	1E+01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Vanadium	NA	NA	NA	NA	Dermal	2E+00	NA	NA	2E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		2E+02	NA	NA	2E+02
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-03	1E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Medium Total				NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		3E+02	1E+02	6E+00	4E+02

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.6	**3**	**5**
Total Dermal HI Across Media =	0.9	**3**	**10**
Total Developmental HI Across Media =	NA	**2**	**5**
Total Endocrine HI Across Media =	1	**4**	**56**
Total Gastrointestinal HI Across Media =	1	0.3	**42**
Total Hematologic HI Across Media =	**9**	**4**	**34**
Total Hepatic HI Across Media =	NA	0.0002	NA
Total Immune HI Across Media =	**8**	**3**	**24**
Total Musculoskeletal HI Across Media =	0.003	NA	NA
Total Nervous HI Across Media =	0.9	**99**	**28**
Total Not specified HI Across Media =	0.3	0.3	0.01
Total Reproductive HI Across Media =	NA	1	NA
Total Respiratory HI Across Media =	NA	**14**	NA
Total Urinary HI Across Media =	**3**	**42**	**68**
Total Whole Body HI Across Media =	0.2	1	**8**

	Total
Total Cardiovascular HI Across Media =	**9**
Total Dermal HI Across Media =	**15**
Total Developmental HI Across Media =	**7**
Total Endocrine HI Across Media =	**61**
Total Gastrointestinal HI Across Media =	**43**
Total Hematologic HI Across Media =	**47**
Total Hepatic HI Across Media =	0.0002
Total Immune HI Across Media =	**35**
Total Musculoskeletal HI Across Media =	0.003
Total Nervous HI Across Media =	**128**
Total Not specified HI Across Media =	0.6
Total Reproductive HI Across Media =	1
Total Respiratory HI Across Media =	**14**
Total Urinary HI Across Media =	**113**
Total Whole Body HI Across Media =	**10**

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	1E-05	8E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Phosphorus	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Strontium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	1E-05	8E-05		NA	NA	NA	NA
	Exposure Medium Total			7E-05	NA	1E-05	8E-05		NA	NA	NA	NA
Medium Total				7E-05	NA	1E-05	8E-05		NA	NA	NA	NA

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-05	NA	7E-06	5E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	2E-05	NA	2E-04	2E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	2E-04	2E-04		NA	NA	NA	NA
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-04	NA	9E-07	2E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	6E-05	NA	2E-05	9E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-04	NA	3E-05	3E-04		NA	NA	NA	NA

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	8E-05	NA	1E-06	8E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	3E-05	NA	3E-05	5E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-04	NA	3E-05	1E-04		NA	NA	NA	NA
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	9E-05	NA	9E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	5E-04	NA	5E-04	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	1E-03	NA	1E-03	---	NA	NA	NA	NA
			Cobalt	NA	5E-04	NA	5E-04	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	3E-05	NA	3E-05	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	2E-03	NA	2E-03		NA	NA	NA	NA
	Exposure Medium Total			4E-04	2E-03	2E-04	3E-03		NA	NA	NA	NA
Medium Total				4E-04	2E-03	2E-04	3E-03		NA	NA	NA	NA

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	NA	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	NA	7E-05		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-04	NA	NA	4E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	NA	4E-04		NA	NA	NA	NA

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-05	NA	NA	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	NA	3E-05		NA	NA	NA	NA
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	NA	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	NA	6E-05		NA	NA	NA	NA
	Exposure Medium Total			6E-04	NA	NA	6E-04		NA	NA	NA	NA

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-04	NA	NA	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	NA	5E-04		NA	NA	NA	NA
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-07	3E-07		NA	NA	NA	NA
	Exposure Medium Total			5E-04	NA	3E-07	5E-04		NA	NA	NA	NA
Medium Total				1E-03	NA	3E-07	1E-03		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				2E-03	2E-03	2E-04	4E-03		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	4E-02	NA	NA	4E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	NA	4E-02
			Arsenic	1E-05	NA	1E-05	3E-05	Cardiovascular, Dermal	9E-02	NA	2E-02	1E-01
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-01	NA	9E-02	5E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	5E-02	NA	NA	5E-02
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	6E-03	NA	NA	6E-03
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	NA	5E-03
			Silver	NA	NA	NA	NA	Dermal	4E-04	NA	NA	4E-04
			Strontium	NA	NA	NA	NA	Musculoskeletal	5E-04	NA	NA	5E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	NA	1E+00
		Exposure Point Total		1E-05	NA	1E-05	3E-05		3E+00	NA	1E-01	3E+00
	Exposure Medium Total			1E-05	NA	1E-05	3E-05		3E+00	NA	1E-01	3E+00
Medium Total				1E-05	NA	1E-05	3E-05		3E+00	NA	1E-01	3E+00

TABLE 9.4.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Aluminum	NA	NA	NA	NA	Nervous	4E-03	NA	8E-04	5E-03
			Antimony	NA	NA	NA	NA	NA	3E-02	NA	4E-02	7E-02
			Arsenic	9E-06	NA	2E-06	1E-05	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	6E-02	NA	1E-02	7E-02
			Barium	NA	NA	NA	NA	Developmental	2E-03	NA	6E-03	8E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-01	NA	2E+00	2E+00
			Chromium (hexavalent)	3E-06	NA	5E-05	5E-05	Respiratory	5E-03	NA	8E-02	9E-02
			Cobalt	NA	NA	NA	NA	Respiratory	1E-01	NA	1E-02	2E-01
			Copper	NA	NA	NA	NA	NA	2E-03	NA	4E-04	2E-03
			Iron	NA	NA	NA	NA	NA	7E-03	NA	2E-03	9E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	8E-01	9E-01
			Nickel	NA	NA	NA	NA	Respiratory	5E-03	NA	5E-03	1E-02
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	5E-04	NA	1E-04	7E-04
			Vanadium	NA	NA	NA	NA	Respiratory	2E-03	NA	2E-02	2E-02
			Zinc	NA	NA	NA	NA	NA	1E-01	NA	2E-02	1E-01
		Exposure Point Total		1E-05	NA	5E-05	6E-05		9E-01	NA	3E+00	4E+00
	Exposure Medium Total			1E-05	NA	5E-05	6E-05		9E-01	NA	3E+00	4E+00
Medium Total				1E-05	NA	5E-05	6E-05		9E-01	NA	3E+00	4E+00
Receptor Total (Sediment + Surface Water)				3E-05	NA	6E-05	9E-05		4E+00	NA	3E+00	6E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW
Total Cardiovascular HI Across Media =	0.1	0.07
Total Dermal HI Across Media =	0.2	0.07
Total Developmental HI Across Media =	NA	0.08
Total Endocrine HI Across Media =	0.2	NA
Total Gastrointestinal HI Across Media =	0.2	NA
Total Hematologic HI Across Media =	1	NA
Total Hepatic HI Across Media =	NA	0.0007
Total Immune HI Across Media =	1	NA
Total Musculoskeletal HI Across Media =	0.0005	NA
Total Nervous HI Across Media =	0.2	1
Total Not specified HI Across Media =	0.05	NA
Total Reproductive HI Across Media =	NA	0.07
Total Respiratory HI Across Media =	NA	0.3
Total Urinary HI Across Media =	0.6	**2**
Total Whole Body HI Across Media =	0.04	NA

	Total
Total Cardiovascular HI Across Media =	0.2
Total Dermal HI Across Media =	0.2
Total Developmental HI Across Media =	0.08
Total Endocrine HI Across Media =	0.2
Total Gastrointestinal HI Across Media =	0.2
Total Hematologic HI Across Media =	1
Total Hepatic HI Across Media =	0.0007
Total Immune HI Across Media =	1
Total Musculoskeletal HI Across Media =	0.0005
Total Nervous HI Across Media =	1
Total Not specified HI Across Media =	0.05
Total Reproductive HI Across Media =	0.07
Total Respiratory HI Across Media =	0.3
Total Urinary HI Across Media =	**3**
Total Whole Body HI Across Media =	0.04

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	9E-04	NA	NA	9E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-03	NA	5E-04	3E-03
			Barium	NA	NA	NA	NA	Urinary	2E-04	NA	NA	2E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-04	NA	NA	1E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-02	NA	2E-03	1E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-06	NA	NA	4E-06
			Cobalt	NA	NA	NA	NA	Endocrine	5E-03	NA	NA	5E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-04	NA	NA	5E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	1E-03	NA	NA	1E-03
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-04	NA	NA	2E-04
			Nickel	NA	NA	NA	NA	Whole Body	1E-04	NA	NA	1E-04
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-04	NA	NA	1E-04
			Silver	NA	NA	NA	NA	Dermal	1E-05	NA	NA	1E-05
			Strontium	NA	NA	NA	NA	Musculoskeletal	1E-05	NA	NA	1E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-03	NA	NA	1E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		7E-02	NA	2E-03	7E-02
	Exposure Medium Total			NA	NA	NA	NA		7E-02	NA	2E-03	7E-02
Medium Total				NA	NA	NA	NA		7E-02	NA	2E-03	7E-02

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	6E-05	NA	1E-05	8E-05
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-04	NA	7E-04	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-04	NA	2E-04	1E-03
			Barium	NA	NA	NA	NA	Urinary	3E-05	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	7E-03	NA	3E-02	4E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	8E-05	NA	1E-03	1E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E-03	NA	2E-04	2E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-05	NA	7E-06	4E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-04	NA	3E-05	1E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-03	NA	1E-02	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-05	NA	9E-05	2E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	9E-06	NA	2E-06	1E-05
			Vanadium	NA	NA	NA	NA	Dermal	4E-05	NA	3E-04	4E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-03	NA	3E-04	2E-03
		Exposure Point Total		NA	NA	NA	NA		2E-02	NA	5E-02	6E-02
		Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	8E-06	8E-06
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	4E-04	4E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-04	1E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	6E-05	6E-05
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-02	2E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	9E-04	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	1E-04	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	4E-06	4E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	2E-05	2E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	8E-03	8E-03
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	5E-05	5E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	1E-06	1E-06
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	2E-04	2E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	2E-04	2E-04
		Exposure Point Total		NA	NA	NA	NA		NA	NA	3E-02	3E-02

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	1E-04	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	6E-03	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	2E-03	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	8E-04	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E-01	3E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	3E-02	NA	1E-02	4E-02
			Cobalt	NA	NA	NA	NA	Endocrine	8E-01	NA	2E-03	8E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	6E-05	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	2E-04	4E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	8E-01	NA	1E-01	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	8E-04	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	2E-05	3E-03
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	3E-03	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	2E-03	7E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	4E-01	6E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		5E+00	NA	4E-01	6E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		5E+00	NA	4E-01	6E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		5E+00	NA	4E-01	6E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		5E+00	NA	4E-01	6E+00

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-01	NA	NA	5E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	NA	9E-02
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-02	NA	NA	3E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	4E-01	NA	NA	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	NA	3E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	NA	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	NA	1E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		7E+00	NA	4E-01	7E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		7E+00	NA	4E-01	7E+00

TABLE 9.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.003	0.3	0.09
Total Dermal HI Across Media =	0	0.3	0.3
Total Developmental HI Across Media =	NA	NA	0.4
Total Endocrine HI Across Media =	0.005	0.8	0.2
Total Gastrointestinal HI Across Media =	0.004	0.05	0.02
Total Hematologic HI Across Media =	0.04	0.8	0.7
Total Immune HI Across Media =	0.035	0.7	0.03
Total Musculoskeletal HI Across Media =	0.00001	NA	NA
Total Nervous HI Across Media =	0.004	1	1
Total Not specified HI Across Media =	0.001	0.04	0.0002
Total Reproductive HI Across Media =	NA	NA	NA
Total Urinary HI Across Media =	0.01	**3**	0.03
Total Whole Body HI Across Media =	0.001	0.2	0.5

	Total
Total Cardiovascular HI Across Media =	0.4
Total Dermal HI Across Media =	1
Total Developmental HI Across Media =	0.4
Total Endocrine HI Across Media =	1
Total Gastrointestinal HI Across Media =	0.08
Total Hematologic HI Across Media =	**2**
Total Immune HI Across Media =	0.7
Total Musculoskeletal HI Across Media =	0.00001
Total Nervous HI Across Media =	**2**
Total Not specified HI Across Media =	0.04
Total Reproductive HI Across Media =	NA
Total Urinary HI Across Media =	**3**
Total Whole Body HI Across Media =	0.7

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	9E-03	NA	NA	9E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-02	NA	3E-03	3E-02
			Barium	NA	NA	NA	NA	Urinary	2E-03	NA	NA	2E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	NA	1E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-02	1E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-05	NA	NA	4E-05
			Cobalt	NA	NA	NA	NA	Endocrine	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	1E-02	NA	NA	1E-02
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-03	NA	NA	2E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-03	NA	NA	1E-03
			Silver	NA	NA	NA	NA	Dermal	1E-04	NA	NA	1E-04
			Strontium	NA	NA	NA	NA	Musculoskeletal	1E-04	NA	NA	1E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		7E-01	NA	1E-02	7E-01
	Exposure Medium Total			NA	NA	NA	NA		7E-01	NA	1E-02	7E-01
Medium Total				NA	NA	NA	NA		7E-01	NA	1E-02	7E-01

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	4E-04	NA	2E-05	5E-04
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	3E-03	NA	1E-03	5E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-03	NA	3E-04	7E-03
			Barium	NA	NA	NA	NA	Urinary	2E-04	NA	2E-04	4E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-02	NA	5E-02	1E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	6E-04	NA	2E-03	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E-02	NA	3E-04	2E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-04	NA	1E-05	2E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	8E-04	NA	4E-05	9E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-02	NA	2E-02	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	6E-04	NA	2E-04	7E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-05	NA	3E-06	6E-05
			Vanadium	NA	NA	NA	NA	Dermal	3E-04	NA	6E-04	8E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	4E-04	1E-02
		Exposure Point Total		NA	NA	NA	NA		1E-01	NA	8E-02	2E-01
		Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	2E-05	2E-05
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	9E-04	9E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	3E-04	3E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	4E-02	4E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	2E-03	2E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	3E-04	3E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	9E-06	9E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	3E-05	3E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	2E-02	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	1E-04	1E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	2E-06	2E-06
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	4E-04	4E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	3E-04	3E-04
		Exposure Point Total		NA	NA	NA	NA		NA	NA	6E-02	6E-02

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	4E-02	NA	2E-04	4E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	3E-01	NA	8E-03	3E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	5E-01	NA	2E-03	5E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E+00	NA	3E-01	4E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	5E-02	NA	2E-02	6E-02
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	2E-03	1E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	8E-05	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-02	NA	3E-04	7E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E+00	NA	1E-01	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	5E-02	NA	1E-03	5E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	2E-05	5E-03
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	4E-03	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	3E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		9E+00	NA	5E-01	9E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		9E+00	NA	6E-01	9E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		9E+00	NA	6E-01	9E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		9E+00	NA	6E-01	9E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		9E+00	NA	6E-01	9E+00

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E+00	NA	NA	1E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	NA	2E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-02	NA	NA	8E-02
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
Medium Total				NA	NA	NA	NA		4E+00	NA	NA	4E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		1E+01	NA	6E-01	1E+01
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		1E+01	NA	6E-01	1E+01

TABLE 9.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.03	0.5	0.2
Total Dermal HI Across Media =	0	0.6	0.7
Total Developmental HI Across Media =	NA	NA	1
Total Endocrine HI Across Media =	0.05	1	0.5
Total Gastrointestinal HI Across Media =	0.05	0.09	0.05
Total Hematologic HI Across Media =	0.4	1	**2**
Total Immune HI Across Media =	0.4	1	0.08
Total Musculoskeletal HI Across Media =	0.0001	NA	NA
Total Nervous HI Across Media =	0.04	**2**	**2**
Total Not specified HI Across Media =	0.01	0.07	0.0005
Total Reproductive HI Across Media =	NA	NA	NA
Total Urinary HI Across Media =	0.1	**4**	0.09
Total Whole Body HI Across Media =	0.01	0.3	1

	Total
Total Cardiovascular HI Across Media =	0.8
Total Dermal HI Across Media =	1
Total Developmental HI Across Media =	1
Total Endocrine HI Across Media =	**2**
Total Gastrointestinal HI Across Media =	0.2
Total Hematologic HI Across Media =	**4**
Total Immune HI Across Media =	**2**
Total Musculoskeletal HI Across Media =	0.0001
Total Nervous HI Across Media =	**3**
Total Not specified HI Across Media =	0.08
Total Reproductive HI Across Media =	NA
Total Urinary HI Across Media =	**5**
Total Whole Body HI Across Media =	**2**

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	1E-06	NA	2E-07	1E-06	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Phosphorus	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Strontium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-06	NA	2E-07	1E-06		NA	NA	NA	NA
	Exposure Medium Total			1E-06	NA	2E-07	1E-06		NA	NA	NA	NA
Medium Total				1E-06	NA	2E-07	1E-06		NA	NA	NA	NA

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-07	NA	4E-08	4E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	5E-07	NA	3E-06	3E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		8E-07	NA	3E-06	4E-06		NA	NA	NA	NA
		Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-08	3E-08	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	NA	2E-06	2E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	2E-06	2E-06		NA	NA	NA	NA

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	3E-07	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	6E-05	NA	2E-05	8E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-04	NA	2E-05	1E-04		NA	NA	NA	NA
	Exposure Medium Total (Swimming + Potable Use)			1E-04	NA	3E-05	1E-04		NA	NA	NA	NA
	Exposure Medium Total (Wading + Potable Use)			1E-04	NA	2E-05	1E-04		NA	NA	NA	NA
Medium Total (Swimming + Potable Use)				1E-04	NA	3E-05	1E-04		NA	NA	NA	NA
Medium Total (Wading + Potable Use)				1E-04	NA	2E-05	1E-04		NA	NA	NA	NA

TABLE 9.7.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	NA	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-05	NA	NA	2E-05		NA	NA	NA	NA
	Exposure Medium Total			2E-05	NA	NA	2E-05		NA	NA	NA	NA
Medium Total				2E-05	NA	NA	2E-05		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)				1E-04	NA	3E-05	2E-04		NA	NA	NA	NA
Receptor Total (Sediment + Wading + Potable Use + Fish)				1E-04	NA	3E-05	2E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	7E-02	NA	NA	7E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	9E-01	NA	NA	9E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-01	NA	1E-01	6E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E-01	2E+00
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Cobalt	NA	NA	NA	NA	Endocrine	6E-01	NA	NA	6E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-01	NA	NA	7E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	1E-01	NA	NA	1E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	4E-03	NA	NA	4E-03
			Molybdenum	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	NA	5E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	9E-04	NA	NA	9E-04
			Strontium	NA	NA	NA	NA	Musculoskeletal	7E-04	NA	NA	7E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	5E-01	6E+00
	Exposure Medium Total			NA	NA	NA	NA		5E+00	NA	5E-01	6E+00
Medium Total				NA	NA	NA	NA		5E+00	NA	5E-01	6E+00

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	7E-04	4E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E-02	NA	1E-02	2E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	2E-01	9E-01
			Barium	NA	NA	NA	NA	Urinary	2E-03	NA	5E-03	7E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-04	NA	3E-02	3E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	9E-01	1E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	8E-03	NA	1E-01	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	7E-01	NA	6E-02	8E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	2E-04	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-01	NA	1E-01	6E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	2E+00	3E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-03	NA	4E-03	5E-03
			Molybdenum	NA	NA	NA	NA	Urinary	1E-02	NA	3E-03	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-01	NA	1E-01	2E-01
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-03	NA	2E-04	1E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	3E-04	NA	1E-03	1E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	9E-02	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	2E-02	2E-01
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	4E+00	7E+00

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	9E-05	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-02	NA	2E-03	5E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E+00	NA	2E-02	4E+00
			Barium	NA	NA	NA	NA	Urinary	9E-03	NA	7E-04	1E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	4E-03	9E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E+00	NA	1E-01	1E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	4E-02	NA	2E-02	6E-02
			Cobalt	NA	NA	NA	NA	Endocrine	4E+00	NA	8E-03	4E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	3E-05	6E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	3E+00	NA	1E-02	3E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E+00	NA	3E-01	3E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	7E-03	NA	5E-04	7E-03
			Molybdenum	NA	NA	NA	NA	Urinary	7E-02	NA	4E-04	7E-02
			Nickel	NA	NA	NA	NA	Whole Body	6E-01	NA	2E-02	6E-01
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-03	NA	3E-05	6E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	1E-04	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-02	NA	1E-02	7E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	3E-03	8E-01
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	6E-01	2E+01

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	7E-03	NA	1E-04	7E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-02	NA	3E-03	2E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	3E-02	2E+00
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	1E-03	5E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	6E-03	8E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-01	NA	2E-01	6E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-02	NA	3E-02	5E-02
			Cobalt	NA	NA	NA	NA	Endocrine	2E+00	NA	1E-02	2E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	4E-05	2E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E+00	NA	2E-02	1E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E+00	NA	5E-01	1E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	3E-03	NA	8E-04	4E-03
			Molybdenum	NA	NA	NA	NA	Urinary	3E-02	NA	6E-04	3E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	2E-02	3E-01
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-03	NA	5E-05	2E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-04	NA	2E-04	8E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	2E-02	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	4E-03	3E-01
		Exposure Point Total		NA	NA	NA	NA		6E+00	NA	8E-01	7E+00

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	7E-01	NA	7E-01
			Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	2E+01	NA	2E+01
			Barium	NA	NA	NA	NA	Developmental	NA	7E-01	NA	7E-01
			Beryllium	NA	NA	NA	NA	Immune, Respiratory	NA	1E-01	NA	1E-01
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+01	NA	1E+01
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	3E+00	NA	3E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	4E+01	NA	4E+01
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	2E+02	NA	2E+02
			Mercury (HgCl)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Respiratory	NA	3E+01	NA	3E+01
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	3E-04	NA	3E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	NA	6E-01	NA	6E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	3E+02	NA	3E+02
	Exposure Medium Total			NA	NA	NA	NA		2E+01	3E+02	5E+00	3E+02
Medium Total				NA	NA	NA	NA		2E+01	3E+02	5E+00	3E+02

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-03	NA	NA	7E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	NA	7E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	8E-02	NA	NA	8E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	NA	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	NA	6E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	NA	8E-01
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-02	NA	NA	5E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-01	NA	NA	7E-01
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		7E+00	NA	NA	7E+00

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-02	NA	NA	6E-02
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-02	NA	NA	6E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	NA	5E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-03	NA	NA	2E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-01	NA	NA	6E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	NA	1E+01

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-01	NA	NA	7E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	NA	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	3E-03	NA	NA	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E+01	NA	NA	2E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+01	NA	NA	2E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Vanadium	NA	NA	NA	NA	Dermal	9E-01	NA	NA	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-04	7E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	7E-03	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	7E-03	1E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		1E+02	3E+02	6E+00	5E+02

TABLE 9.8.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.6	**22**	**2**
Total Dermal HI Across Media =	0.6	**22**	**4**
Total Developmental HI Across Media =	NA	**16**	**2**
Total Endocrine HI Across Media =	0.6	**6**	**24**
Total Gastrointestinal HI Across Media =	0.7	**4**	**18**
Total Hematologic HI Across Media =	1	1	**15**
Total Hepatic HI Across Media =	NA	0.0003	NA
Total Immune HI Across Media =	0.4	1	**10**
Total Musculoskeletal HI Across Media =	0.0007	NA	NA
Total Nervous HI Across Media =	0.3	**247**	**12**
Total Not specified HI Across Media =	0.1	0.3	0.004
Total Reproductive HI Across Media =	NA	**16**	NA
Total Respiratory HI Across Media =	NA	**82**	NA
Total Urinary HI Across Media =	**2**	**15**	**29**
Total Whole Body HI Across Media =	0.9	1	**4**

	Total
Total Cardiovascular HI Across Media =	**25**
Total Dermal HI Across Media =	**28**
Total Developmental HI Across Media =	**18**
Total Endocrine HI Across Media =	**30**
Total Gastrointestinal HI Across Media =	**23**
Total Hematologic HI Across Media =	**17**
Total Hepatic HI Across Media =	0.0003
Total Immune HI Across Media =	**12**
Total Musculoskeletal HI Across Media =	0.0007
Total Nervous HI Across Media =	**259**
Total Not specified HI Across Media =	0.4
Total Reproductive HI Across Media =	**16**
Total Respiratory HI Across Media =	**82**
Total Urinary HI Across Media =	**46**
Total Whole Body HI Across Media =	**6**

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	3E-01	NA	NA	3E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E+00	NA	NA	4E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	2E-01	2E+00
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E+00	NA	5E-01	9E+00
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	3E+00	NA	NA	3E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	3E+00	NA	NA	3E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	5E-01	NA	NA	5E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	9E-01	NA	NA	9E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-02	NA	NA	2E-02
			Molybdenum	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-02	NA	NA	5E-02
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-02	NA	NA	2E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	4E-03	NA	NA	4E-03
			Strontium	NA	NA	NA	NA	Musculoskeletal	3E-03	NA	NA	3E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-01	NA	NA	3E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	7E-01	3E+01
	Exposure Medium Total			NA	NA	NA	NA		2E+01	NA	7E-01	3E+01
Medium Total				NA	NA	NA	NA		2E+01	NA	7E-01	3E+01

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	8E-04	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	2E-02	6E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E+00	NA	2E-01	4E+00
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	6E-03	1E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	3E-02	4E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E+00	NA	1E+00	2E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	4E-02	NA	2E-01	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	3E+00	NA	7E-02	3E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	3E-04	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	1E-01	2E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E+00	NA	3E+00	5E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	6E-03	NA	4E-03	1E-02
			Molybdenum	NA	NA	NA	NA	Urinary	6E-02	NA	3E-03	6E-02
			Nickel	NA	NA	NA	NA	Whole Body	5E-01	NA	1E-01	7E-01
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	3E-04	5E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-03	NA	1E-03	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	1E-01	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-01	NA	2E-02	7E-01
		Exposure Point Total		NA	NA	NA	NA		1E+01	NA	5E+00	2E+01

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	1E-04	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	7E-02	NA	2E-03	8E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E+00	NA	3E-02	6E+00
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	8E-04	1E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	5E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	1E-01	2E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	6E-02	NA	2E-02	9E-02
			Cobalt	NA	NA	NA	NA	Endocrine	5E+00	NA	1E-02	5E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	4E-05	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+00	NA	2E-02	4E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E+00	NA	4E-01	4E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-02	NA	6E-04	1E-02
			Molybdenum	NA	NA	NA	NA	Urinary	1E-01	NA	5E-04	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	9E-01	NA	2E-02	9E-01
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	8E-03	NA	4E-05	8E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	2E-04	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	9E-02	NA	1E-02	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	3E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	7E-01	2E+01

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	3E-02	NA	2E-04	3E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	9E-02	NA	4E-03	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E+00	NA	5E-02	8E+00
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	2E-03	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	8E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E-01	2E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	8E-02	NA	4E-02	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	7E+00	NA	2E-02	7E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	7E-05	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E+00	NA	3E-02	5E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E+00	NA	7E-01	5E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-02	NA	1E-03	1E-02
			Molybdenum	NA	NA	NA	NA	Urinary	1E-01	NA	8E-04	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	1E+00	NA	4E-02	1E+00
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	7E-05	1E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	3E-03	NA	3E-04	3E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	3E-02	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	5E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		3E+01	NA	1E+00	3E+01

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	7E-01	NA	7E-01
			Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	2E+01	NA	2E+01
			Barium	NA	NA	NA	NA	Developmental	NA	7E-01	NA	7E-01
			Beryllium	NA	NA	NA	NA	Immune, Respiratory	NA	1E-01	NA	1E-01
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+01	NA	1E+01
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	3E+00	NA	3E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	4E+01	NA	4E+01
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	2E+02	NA	2E+02
			Mercury (HgCl)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Respiratory	NA	3E+01	NA	3E+01
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	3E-04	NA	3E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	NA	6E-01	NA	6E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	3E+02	NA	3E+02
	Exposure Medium Total			NA	NA	NA	NA		7E+01	3E+02	7E+00	4E+02
Medium Total				NA	NA	NA	NA		7E+01	3E+02	7E+00	4E+02

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-01	NA	NA	5E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	9E+00	NA	NA	9E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E+00	NA	NA	2E+00
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	NA	2E+01

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	NA	9E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	6E-03	NA	NA	6E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+01	NA	NA	3E+01

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E+00	NA	NA	4E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	NA	9E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-03	NA	NA	8E-03
			Cobalt	NA	NA	NA	NA	Endocrine	5E+01	NA	NA	5E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+01	NA	NA	4E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E+01	NA	NA	1E+01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Vanadium	NA	NA	NA	NA	Dermal	2E+00	NA	NA	2E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		2E+02	NA	NA	2E+02

TABLE 9.9.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-03	1E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Medium Total				NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		3E+02	3E+02	7E+00	6E+02

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	**2**	**33**	**5**
Total Dermal HI Across Media =	**3**	**33**	**10**
Total Developmental HI Across Media =	NA	**16**	**5**
Total Endocrine HI Across Media =	**3**	**16**	**56**
Total Gastrointestinal HI Across Media =	**3**	**11**	**42**
Total Hematologic HI Across Media =	**6**	**3**	**34**
Total Hepatic HI Across Media =	NA	0.0003	NA
Total Immune HI Across Media =	**2**	**3**	**24**
Total Musculoskeletal HI Across Media =	0.003	NA	NA
Total Nervous HI Across Media =	1	**254**	**28**
Total Not specified HI Across Media =	0.5	0.4	0.01
Total Reproductive HI Across Media =	NA	**16**	NA
Total Respiratory HI Across Media =	NA	**82**	NA
Total Urinary HI Across Media =	**9**	**18**	**68**
Total Whole Body HI Across Media =	**4**	**3**	**8**

	Total
Total Cardiovascular HI Across Media =	**40**
Total Dermal HI Across Media =	**46**
Total Developmental HI Across Media =	**21**
Total Endocrine HI Across Media =	**74**
Total Gastrointestinal HI Across Media =	**56**
Total Hematologic HI Across Media =	**43**
Total Hepatic HI Across Media =	0.0003
Total Immune HI Across Media =	**28**
Total Musculoskeletal HI Across Media =	0.003
Total Nervous HI Across Media =	**283**
Total Not specified HI Across Media =	0.9
Total Reproductive HI Across Media =	**16**
Total Respiratory HI Across Media =	**82**
Total Urinary HI Across Media =	**96**
Total Whole Body HI Across Media =	**15**

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-04	NA	5E-05	3E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Phosphorus	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Strontium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-04	NA	5E-05	3E-04		NA	NA	NA	NA
	Exposure Medium Total			3E-04	NA	5E-05	3E-04		NA	NA	NA	NA
Medium Total				3E-04	NA	5E-05	3E-04		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-04	NA	7E-05	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	3E-05	NA	2E-04	3E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	3E-04	8E-04		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-03	NA	1E-05	2E-03	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	8E-05	NA	3E-05	1E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-03	NA	4E-05	2E-03		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	9E-04	NA	1E-05	9E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	4E-05	NA	3E-05	7E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		9E-04	NA	5E-05	9E-04		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	1E-03	NA	1E-03	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	5E-06	NA	5E-06	---	NA	NA	NA	NA
			Cadmium (water)	NA	2E-04	NA	2E-04	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	2E-03	NA	2E-03	---	NA	NA	NA	NA
			Cobalt	NA	2E-03	NA	2E-03	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	6E-04	NA	6E-04	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	5E-03	NA	5E-03		NA	NA	NA	NA
	Exposure Medium Total			3E-03	5E-03	4E-04	9E-03		NA	NA	NA	NA
Medium Total				3E-03	5E-03	4E-04	9E-03		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	NA	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	NA	7E-05		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-04	NA	NA	4E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	NA	4E-04		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-05	NA	NA	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	NA	3E-05		NA	NA	NA	NA
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	NA	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	NA	6E-05		NA	NA	NA	NA
	Exposure Medium Total			6E-04	NA	NA	6E-04		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-04	NA	NA	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	NA	5E-04		NA	NA	NA	NA

TABLE 9.10.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-07	3E-07		NA	NA	NA	NA
	Exposure Medium Total			5E-04	NA	3E-07	5E-04		NA	NA	NA	NA
Medium Total				1E-03	NA	3E-07	1E-03		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				5E-03	5E-03	5E-04	1E-02		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.11.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	5E-02	NA	NA	5E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	7E-01	NA	NA	7E-01
			Arsenic	6E-05	NA	5E-05	1E-04	Cardiovascular, Dermal	4E-01	NA	9E-02	4E-01
			Barium	NA	NA	NA	NA	Urinary	3E-03	NA	NA	3E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E+00	NA	3E-01	2E+00
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-05	NA	NA	9E-05
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-01	NA	NA	5E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	8E-02	NA	NA	8E-02
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	3E-03	NA	NA	3E-03
			Molybdenum	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	9E-03	NA	NA	9E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-03	NA	NA	4E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	7E-04	NA	NA	7E-04
			Strontium	NA	NA	NA	NA	Musculoskeletal	6E-04	NA	NA	6E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	NA	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		6E-05	NA	5E-05	1E-04		4E+00	NA	4E-01	5E+00
	Exposure Medium Total			6E-05	NA	5E-05	1E-04		4E+00	NA	4E-01	5E+00
Medium Total				6E-05	NA	5E-05	1E-04		4E+00	NA	4E-01	5E+00

TABLE 9.11.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	5E-04	3E-03
			Antimony	NA	NA	NA	NA	NA	8E-03	NA	1E-02	2E-02
			Arsenic	1E-04	NA	2E-05	1E-04	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	6E-01	NA	1E-01	7E-01
			Barium	NA	NA	NA	NA	Developmental	1E-03	NA	4E-03	5E-03
			Beryllium	NA	NA	NA	NA	Immune, Respiratory	8E-04	NA	2E-02	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	8E-01	9E-01
			Chromium (hexavalent)	4E-06	NA	6E-05	7E-05	Respiratory	7E-03	NA	1E-01	1E-01
			Cobalt	NA	NA	NA	NA	Respiratory	6E-01	NA	5E-02	6E-01
			Copper	NA	NA	NA	NA	NA	8E-04	NA	2E-04	1E-03
			Iron	NA	NA	NA	NA	NA	4E-01	NA	8E-02	5E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-01	NA	2E+00	2E+00
			Mercury (HgCl)	NA	NA	NA	NA	NA	1E-03	NA	3E-03	4E-03
			Molybdenum	NA	NA	NA	NA	NA	1E-02	NA	2E-03	1E-02
			Nickel	NA	NA	NA	NA	Respiratory	9E-02	NA	1E-01	2E-01
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	9E-04	NA	2E-04	1E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	NA	2E-04	NA	8E-04	1E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	9E-03	NA	7E-02	8E-02
			Zinc	NA	NA	NA	NA	NA	1E-01	NA	1E-02	1E-01
		Exposure Point Total		1E-04	NA	8E-05	2E-04		2E+00	NA	3E+00	6E+00
	Exposure Medium Total			1E-04	NA	8E-05	2E-04		2E+00	NA	3E+00	6E+00
Medium Total				1E-04	NA	8E-05	2E-04		2E+00	NA	3E+00	6E+00
Receptor Total (Sediment + Surface Water)				2E-04	NA	1E-04	3E-04		7E+00	NA	4E+00	1E+01

TABLE 9.11.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW
Total Cardiovascular HI Across Media =	0.4	0.7
Total Dermal HI Across Media =	0.5	0.7
Total Developmental HI Across Media =	NA	0.7
Total Endocrine HI Across Media =	0.5	NA
Total Gastrointestinal HI Across Media =	0.5	NA
Total Hematologic HI Across Media =	1	NA
Total Hepatic HI Across Media =	NA	0.001
Total Immune HI Across Media =	0.3	0.02
Total Musculoskeletal HI Across Media =	0.0006	NA
Total Nervous HI Across Media =	0.2	**3**
Total Not specified HI Across Media =	0.08	NA
Total Reproductive HI Across Media =	NA	0.7
Total Respiratory HI Across Media =	NA	**2**
Total Urinary HI Across Media =	**2**	0.9
Total Whole Body HI Across Media =	0.7	NA

	Total
Total Cardiovascular HI Across Media =	1
Total Dermal HI Across Media =	1
Total Developmental HI Across Media =	0.7
Total Endocrine HI Across Media =	0.5
Total Gastrointestinal HI Across Media =	0.5
Total Hematologic HI Across Media =	1
Total Hepatic HI Across Media =	0.001
Total Immune HI Across Media =	0.3
Total Musculoskeletal HI Across Media =	0.0006
Total Nervous HI Across Media =	**3**
Total Not specified HI Across Media =	0.08
Total Reproductive HI Across Media =	0.7
Total Respiratory HI Across Media =	**2**
Total Urinary HI Across Media =	**3**
Total Whole Body HI Across Media =	0.7

TABLE 9.12.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1.E-03	NA	NA	1.E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2.E-02	NA	NA	2.E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9.E-03	NA	2.E-03	1.E-02
			Barium	NA	NA	NA	NA	Urinary	8.E-05	NA	NA	8.E-05
			Beryllium	NA	NA	NA	NA	Gastrointestinal	6.E-05	NA	NA	6.E-05
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3.E-02	NA	6.E-03	4.E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2.E-06	NA	NA	2.E-06
			Cobalt	NA	NA	NA	NA	Endocrine	1.E-02	NA	NA	1.E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	2.E-04	NA	NA	2.E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	1.E-02	NA	NA	1.E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	2.E-03	NA	NA	2.E-03
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4.E-03	NA	NA	4.E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	8.E-05	NA	NA	8.E-05
			Molybdenum	NA	NA	NA	NA	Urinary	2.E-03	NA	NA	2.E-03
			Nickel	NA	NA	NA	NA	Whole Body	2.E-04	NA	NA	2.E-04
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1.E-04	NA	NA	1.E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2.E-05	NA	NA	2.E-05
			Strontium	NA	NA	NA	NA	Musculoskeletal	1.E-05	NA	NA	1.E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1.E-03	NA	NA	1.E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7.E-03	NA	NA	7.E-03
		Exposure Point Total		NA	NA	NA	NA		1.E-01	NA	8.E-03	1.E-01
	Exposure Medium Total			NA	NA	NA	NA		1.E-01	NA	8.E-03	1.E-01
Medium Total				NA	NA	NA	NA		1.E-01	NA	8.E-03	1.E-01

TABLE 9.12.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	4.E-05	NA	9.E-06	5.E-05
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1.E-04	NA	2.E-04	3.E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1.E-02	NA	2.E-03	1.E-02
			Barium	NA	NA	NA	NA	Urinary	2.E-05	NA	7.E-05	9.E-05
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1.E-05	NA	4.E-04	4.E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	3.E-03	NA	1.E-02	2.E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	1.E-04	NA	2.E-03	2.E-03
			Cobalt	NA	NA	NA	NA	Endocrine	9.E-03	NA	8.E-04	1.E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	1.E-05	NA	3.E-06	2.E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	6.E-03	NA	1.E-03	8.E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6.E-03	NA	3.E-02	4.E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2.E-05	NA	5.E-05	7.E-05
			Molybdenum	NA	NA	NA	NA	Urinary	2.E-04	NA	4.E-05	2.E-04
			Nickel	NA	NA	NA	NA	Whole Body	1.E-03	NA	2.E-03	3.E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1.E-05	NA	3.E-06	2.E-05
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	4.E-06	NA	1.E-05	2.E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1.E-04	NA	1.E-03	1.E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2.E-03	NA	2.E-04	2.E-03
		Exposure Point Total		NA	NA	NA	NA		4.E-02	NA	5.E-02	9.E-02

TABLE 9.12.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	5.E-06	5.E-06
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	1.E-04	1.E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1.E-03	1.E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	4.E-05	4.E-05
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	2.E-04	2.E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	8.E-03	8.E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	1.E-03	1.E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	5.E-04	5.E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	2.E-06	2.E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	8.E-04	8.E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	2.E-02	2.E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	NA	NA	3.E-05	3.E-05
			Molybdenum	NA	NA	NA	NA	Urinary	NA	NA	2.E-05	2.E-05
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	1.E-03	1.E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	2.E-06	2.E-06
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	NA	NA	8.E-06	8.E-06
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	7.E-04	7.E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	1.E-04	1.E-04
		Exposure Point Total		NA	NA	NA	NA		NA	NA	3.E-02	3.E-02

TABLE 9.12.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	1.E-02	NA	8.E-05	1.E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4.E-02	NA	2.E-03	4.E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3.E+00	NA	2.E-02	3.E+00
			Barium	NA	NA	NA	NA	Urinary	7.E-03	NA	6.E-04	8.E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4.E-03	NA	3.E-03	8.E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	1.E+00	NA	1.E-01	1.E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	4.E-02	NA	2.E-02	5.E-02
			Cobalt	NA	NA	NA	NA	Endocrine	3.E+00	NA	7.E-03	3.E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	5.E-03	NA	3.E-05	5.E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2.E+00	NA	1.E-02	2.E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2.E+00	NA	3.E-01	2.E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	6.E-03	NA	5.E-04	6.E-03
			Molybdenum	NA	NA	NA	NA	Urinary	6.E-02	NA	3.E-04	6.E-02
			Nickel	NA	NA	NA	NA	Whole Body	5.E-01	NA	1.E-02	5.E-01
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5.E-03	NA	3.E-05	5.E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1.E-03	NA	1.E-04	1.E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5.E-02	NA	1.E-02	6.E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6.E-01	NA	2.E-03	6.E-01
		Exposure Point Total		NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01

TABLE 9.12.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1.E-03	NA	NA	1.E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5.E-01	NA	NA	5.E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9.E-02	NA	NA	9.E-02
			Barium	NA	NA	NA	NA	Urinary	1.E-03	NA	NA	1.E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5.E-03	NA	NA	5.E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3.E-02	NA	NA	3.E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2.E-04	NA	NA	2.E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2.E-01	NA	NA	2.E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1.E-02	NA	NA	1.E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4.E-03	NA	NA	4.E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1.E-02	NA	NA	1.E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	4.E-01	NA	NA	4.E-01
			Nickel	NA	NA	NA	NA	Whole Body	3.E-03	NA	NA	3.E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1.E-01	NA	NA	1.E-01
			Silver	NA	NA	NA	NA	Dermal	3.E-02	NA	NA	3.E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3.E-02	NA	NA	3.E-02
		Exposure Point Total		NA	NA	NA	NA		1.E+00	NA	NA	1.E+00
	Exposure Medium Total			NA	NA	NA	NA		1.E+00	NA	NA	1.E+00
Medium Total				NA	NA	NA	NA		1.E+00	NA	NA	1.E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		1.E+01	NA	5.E-01	2.E+01
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		1.E+01	NA	5.E-01	2.E+01

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.01	**3**	0.09
Total Dermal HI Across Media =	0.01	**3**	0.3
Total Developmental HI Across Media =	NA	NA	0.4
Total Endocrine HI Across Media =	0.01	**3**	0.2
Total Gastrointestinal HI Across Media =	0.01	**2**	0.02
Total Hematologic HI Across Media =	0.02	0.7	0.7
Total Immune HI Across Media =	0.007	0.6	0.03
Total Musculoskeletal HI Across Media =	0.00001	NA	NA
Total Nervous HI Across Media =	0.005	**2**	0.6
Total Not specified HI Across Media =	0.002	0.06	0.0002
Total Urinary HI Across Media =	0.04	1	0.03
Total Whole Body HI Across Media =	0.02	0.6	0.5

	Total
Total Cardiovascular HI Across Media =	**4**
Total Dermal HI Across Media =	**4**
Total Developmental HI Across Media =	0.4
Total Endocrine HI Across Media =	**3**
Total Gastrointestinal HI Across Media =	**2**
Total Hematologic HI Across Media =	1
Total Immune HI Across Media =	0.7
Total Musculoskeletal HI Across Media =	0.00001
Total Nervous HI Across Media =	**3**
Total Not specified HI Across Media =	0.06
Total Urinary HI Across Media =	1
Total Whole Body HI Across Media =	1

TABLE 9.13.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	NA	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	1E-02	1E-01
			Barium	NA	NA	NA	NA	Urinary	9E-04	NA	NA	9E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	6E-04	NA	NA	6E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	4E-01	NA	3E-02	4E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-05	NA	NA	2E-05
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	2E-02	NA	NA	2E-02
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-02	NA	NA	4E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	8E-04	NA	NA	8E-04
			Molybdenum	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-03	NA	NA	1E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-04	NA	NA	2E-04
			Strontium	NA	NA	NA	NA	Musculoskeletal	2E-04	NA	NA	2E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	5E-02	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	5E-02	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	5E-02	1E+00

TABLE 9.13.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	3E-04	NA	2E-05	3E-04
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	9E-04	NA	3E-04	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	7E-02	NA	4E-03	7E-02
			Barium	NA	NA	NA	NA	Urinary	2E-04	NA	1E-04	3E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-05	NA	7E-04	7E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	2E-02	4E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	8E-04	NA	3E-03	4E-03
			Cobalt	NA	NA	NA	NA	Endocrine	6E-02	NA	1E-03	7E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-05	NA	5E-06	1E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	2E-03	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-02	NA	5E-02	1E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-04	NA	9E-05	2E-04
			Molybdenum	NA	NA	NA	NA	Urinary	1E-03	NA	7E-05	1E-03
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	3E-03	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-04	NA	5E-06	1E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	3E-05	NA	2E-05	5E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-03	NA	2E-03	3E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	4E-04	1E-02
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	9E-02	4E-01

TABLE 9.13.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	1E-05	1E-05
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	2E-04	2E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	3E-03	3E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	9E-05	9E-05
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	5E-04	5E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-02	2E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	2E-03	2E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	1E-03	1E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	4E-06	4E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	2E-03	2E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	4E-02	4E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	NA	NA	7E-05	7E-05
			Molybdenum	NA	NA	NA	NA	Urinary	NA	NA	5E-05	5E-05
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	2E-03	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	4E-06	4E-06
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	NA	NA	2E-05	2E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	2E-03	2E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	3E-04	3E-04
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-02	7E-02

TABLE 9.13.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	1E-04	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	7E-02	NA	2E-03	7E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E+00	NA	2E-02	6E+00
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	8E-04	1E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	4E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	1E-01	2E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	6E-02	NA	2E-02	8E-02
			Cobalt	NA	NA	NA	NA	Endocrine	5E+00	NA	9E-03	5E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	3E-05	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+00	NA	2E-02	4E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E+00	NA	4E-01	4E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-02	NA	6E-04	1E-02
			Molybdenum	NA	NA	NA	NA	Urinary	1E-01	NA	4E-04	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	8E-01	NA	2E-02	9E-01
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	8E-03	NA	4E-05	8E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	1E-04	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	8E-02	NA	1E-02	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	3E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	6E-01	2E+01
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		2E+01	NA	7E-01	2E+01
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		2E+01	NA	7E-01	2E+01
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		2E+01	NA	7E-01	2E+01
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		2E+01	NA	7E-01	2E+01

TABLE 9.13.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E+00	NA	NA	1E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	NA	2E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-02	NA	NA	8E-02
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
Medium Total				NA	NA	NA	NA		4E+00	NA	NA	4E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		3E+01	NA	8E-01	3E+01
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		3E+01	NA	7E-01	3E+01

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.1	**6**	0.2
Total Dermal HI Across Media =	0.1	**6**	0.7
Total Developmental HI Across Media =	NA	NA	1
Total Endocrine HI Across Media =	0.1	**5**	0.5
Total Gastrointestinal HI Across Media =	0.1	**4**	0.05
Total Hematologic HI Across Media =	0.3	1	**2**
Total Immune HI Across Media =	0.07	1	0.08
Total Musculoskeletal HI Across Media =	0.0002	NA	NA
Total Nervous HI Across Media =	0.05	**4**	**2**
Total Not specified HI Across Media =	0.02	0.09	0.0005
Total Urinary HI Across Media =	0.4	**2**	0.09
Total Whole Body HI Across Media =	0.2	0.9	1

	Total
Total Cardiovascular HI Across Media =	**6**
Total Dermal HI Across Media =	**7**
Total Developmental HI Across Media =	1
Total Endocrine HI Across Media =	**6**
Total Gastrointestinal HI Across Media =	**4**
Total Hematologic HI Across Media =	**3**
Total Immune HI Across Media =	1
Total Musculoskeletal HI Across Media =	0.0002
Total Nervous HI Across Media =	**5**
Total Not specified HI Across Media =	0.1
Total Urinary HI Across Media =	**2**
Total Whole Body HI Across Media =	**2**

TABLE 9.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-06	NA	7E-07	5E-06	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Phosphorus	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Strontium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-06	NA	7E-07	5E-06		NA	NA	NA	NA
	Exposure Medium Total			5E-06	NA	7E-07	5E-06		NA	NA	NA	NA
Medium Total				5E-06	NA	7E-07	5E-06		NA	NA	NA	NA

TABLE 9.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-06	NA	4E-07	4E-06	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	6E-07	NA	4E-06	4E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-06	NA	4E-06	9E-06		NA	NA	NA	NA

TABLE 9.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	NA	3E-06	3E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-06	3E-06		NA	NA	NA	NA

TABLE 9.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-04	NA	3E-06	7E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	7E-05	NA	3E-05	1E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-04	NA	3E-05	8E-04		NA	NA	NA	NA
	Exposure Medium Total (Swimming + Potable Use)			7E-04	NA	4E-05	8E-04		NA	NA	NA	NA
	Exposure Medium Total (Wading + Potable Use)			7E-04	NA	4E-05	8E-04		NA	NA	NA	NA
Medium Total (Swimming + Potable Use)				7E-04	NA	4E-05	8E-04		NA	NA	NA	NA
Medium Total (Wading + Potable Use)				7E-04	NA	4E-05	8E-04		NA	NA	NA	NA

TABLE 9.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	NA	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-05	NA	NA	2E-05		NA	NA	NA	NA
	Exposure Medium Total			2E-05	NA	NA	2E-05		NA	NA	NA	NA
Medium Total				2E-05	NA	NA	2E-05		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)				8E-04	NA	4E-05	8E-04		NA	NA	NA	NA
Receptor Total (Sediment + Wading + Potable Use + Fish)				8E-04	NA	4E-05	8E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	9E-02	NA	NA	9E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	2E-02	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-03	NA	NA	5E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-02	NA	6E-03	4E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-05	NA	NA	8E-05
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	NA	1E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-04	NA	NA	1E-04
			Molybdenum	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	NA	1E-02
			Silver	NA	NA	NA	NA	Dermal	8E-03	NA	NA	8E-03
			Vanadium	NA	NA	NA	NA	Dermal	4E-02	NA	NA	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-03	NA	NA	8E-03
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	3E-02	2E+00
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	3E-02	2E+00
Medium Total				NA	NA	NA	NA		2E+00	NA	3E-02	2E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	1E-02	7E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-02	NA	2E-02	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-03	NA	2E-02	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-03	NA	2E-02	3E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-02	NA	3E-01	4E-01
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	9E-03	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	5E-04	3E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-02	NA	1E-02	8E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	7E-02	NA	4E-01	4E-01
			Molybdenum	NA	NA	NA	NA	Urinary	1E-03	NA	2E-04	1E-03
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	3E-03	7E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-04	NA	1E-04	8E-04
			Vanadium	NA	NA	NA	NA	Dermal	7E-03	NA	6E-02	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-03	NA	2E-04	2E-03
		Exposure Point Total		NA	NA	NA	NA		4E-01	NA	9E-01	1E+00

TABLE 9.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	3E-01	NA	2E-03	3E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-01	NA	2E-03	4E-01
			Barium	NA	NA	NA	NA	Urinary	3E-02	NA	2E-03	3E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	3E-02	NA	3E-03	3E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	1E-01	NA	5E-02	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	1E-03	6E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	6E-05	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-01	NA	2E-03	4E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-01	NA	5E-02	4E-01
			Molybdenum	NA	NA	NA	NA	Urinary	6E-03	NA	3E-05	6E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	5E-04	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-03	NA	2E-05	4E-03
			Vanadium	NA	NA	NA	NA	Dermal	4E-02	NA	8E-03	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E-03	NA	3E-05	9E-03
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
		Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	2E-03	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	3E-03	2E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	3E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-02	NA	4E-03	2E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	4E-02	NA	7E-02	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	2E-03	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	9E-05	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	3E-03	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	7E-02	2E-01
			Molybdenum	NA	NA	NA	NA	Urinary	2E-03	NA	4E-05	2E-03
			Nickel	NA	NA	NA	NA	Whole Body	7E-03	NA	7E-04	7E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-03	NA	3E-05	1E-03
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	1E-02	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-03	NA	4E-05	4E-03
		Exposure Point Total		NA	NA	NA	NA		9E-01	NA	2E-01	1E+00

TABLE 9.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	1E+01	NA	1E+01
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	2E+00	NA	2E+00
			Barium	NA	NA	NA	NA	Developmental	NA	2E+00	NA	2E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E-01	NA	3E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	8E+00	NA	8E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	5E+00	NA	5E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	3E+01	NA	3E+01
			Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Respiratory	NA	7E-01	NA	7E-01
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	2E-04	NA	2E-04
			Vanadium	NA	NA	NA	NA	Respiratory	NA	4E-01	NA	4E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	6E+01	NA	6E+01
	Exposure Medium Total			NA	NA	NA	NA		4E+00	6E+01	1E+00	7E+01
Medium Total				NA	NA	NA	NA		4E+00	6E+01	1E+00	7E+01
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-03	NA	NA	7E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	NA	7E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	8E-02	NA	NA	8E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	NA	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00

TABLE 9.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	NA	6E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	NA	8E-01
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-02	NA	NA	5E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-01	NA	NA	7E-01
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		7E+00	NA	NA	7E+00
		Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-02	NA	NA	6E-02
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-02	NA	NA	6E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01

TABLE 9.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	NA	5E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-03	NA	NA	2E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-01	NA	NA	6E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	NA	1E+01
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-01	NA	NA	7E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	NA	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	3E-03	NA	NA	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E+01	NA	NA	2E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+01	NA	NA	2E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Vanadium	NA	NA	NA	NA	Dermal	9E-01	NA	NA	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01

TABLE 9.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-04	7E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	7E-03	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	7E-03	1E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		1E+02	6E+01	1E+00	2E+02

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.1	**2**	**2**
Total Dermal HI Across Media =	0.2	**3**	**4**
Total Developmental HI Across Media =	NA	**4**	**2**
Total Endocrine HI Across Media =	1	0.9	**24**
Total Gastrointestinal HI Across Media =	0.2	0.6	**18**
Total Hematologic HI Across Media =	0.02	0.02	**15**
Total Hepatic HI Across Media =	NA	0.0002	NA
Total Immune HI Across Media =	0.008	0.01	**10**
Total Nervous HI Across Media =	0.3	**50**	**12**
Total Not specified HI Across Media =	0.00008	0.6	0.004
Total Reproductive HI Across Media =	NA	**2**	NA
Total Respiratory HI Across Media =	NA	**16**	NA
Total Urinary HI Across Media =	0.1	0.4	**29**
Total Whole Body HI Across Media =	0.006	0.03	**4**

	Total
Total Cardiovascular HI Across Media =	**5**
Total Dermal HI Across Media =	**7**
Total Developmental HI Across Media =	**6**
Total Endocrine HI Across Media =	**26**
Total Gastrointestinal HI Across Media =	**19**
Total Hematologic HI Across Media =	**15**
Total Hepatic HI Across Media =	0.0002
Total Immune HI Across Media =	**10**
Total Nervous HI Across Media =	**62**
Total Not specified HI Across Media =	0.6
Total Reproductive HI Across Media =	**2**
Total Respiratory HI Across Media =	**16**
Total Urinary HI Across Media =	**30**
Total Whole Body HI Across Media =	**4**

TABLE 9.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	4E-01	NA	NA	4E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-01	NA	4E-02	5E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	9E-03	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	6E+00	NA	NA	6E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	8E-01	NA	NA	8E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	8E-01	NA	NA	8E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	6E-04	NA	NA	6E-04
			Molybdenum	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	NA	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silver	NA	NA	NA	NA	Dermal	4E-02	NA	NA	4E-02
			Vanadium	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-02	NA	NA	4E-02
		Exposure Point Total		NA	NA	NA	NA		9E+00	NA	4E-02	9E+00
	Exposure Medium Total			NA	NA	NA	NA		9E+00	NA	4E-02	9E+00
Medium Total				NA	NA	NA	NA		9E+00	NA	4E-02	9E+00

TABLE 9.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	3E-01	NA	1E-02	3E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-01	NA	2E-02	4E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	2E-02	4E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	3E-02	5E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	9E-02	NA	4E-01	5E-01
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	1E-02	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	5E-04	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-01	NA	2E-02	3E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	4E-01	7E-01
			Molybdenum	NA	NA	NA	NA	Urinary	5E-03	NA	3E-04	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	4E-03	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	2E-04	3E-03
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	6E-02	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-03	NA	2E-04	8E-03
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	1E+00	3E+00
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	5E-01	NA	2E-03	5E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-01	NA	3E-03	6E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	3E-03	4E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-02	NA	4E-03	4E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-01	NA	6E-02	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	8E-01	NA	1E-03	8E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	7E-05	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-01	NA	2E-03	5E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	6E-02	6E-01
			Molybdenum	NA	NA	NA	NA	Urinary	8E-03	NA	4E-05	8E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	5E-04	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	2E-05	5E-03
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	9E-03	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	3E-05	1E-02
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	1E-01	3E+00

TABLE 9.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	6E-01	NA	4E-03	6E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	5E-03	8E-01
			Barium	NA	NA	NA	NA	Urinary	5E-02	NA	5E-03	6E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-02	NA	7E-03	6E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-01	NA	1E-01	3E-01
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	3E-03	1E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	1E-04	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-01	NA	4E-03	7E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	7E-01	NA	1E-01	8E-01
			Molybdenum	NA	NA	NA	NA	Urinary	1E-02	NA	7E-05	1E-02
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	1E-03	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-03	NA	4E-05	7E-03
			Vanadium	NA	NA	NA	NA	Dermal	7E-02	NA	2E-02	8E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-02	NA	6E-05	2E-02
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	3E-01	4E+00
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	1E+01	NA	1E+01
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	2E+00	NA	2E+00
			Barium	NA	NA	NA	NA	Developmental	NA	2E+00	NA	2E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E-01	NA	3E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	8E+00	NA	8E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	5E+00	NA	5E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	3E+01	NA	3E+01
			Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Respiratory	NA	7E-01	NA	7E-01
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	2E-04	NA	2E-04
			Vanadium	NA	NA	NA	NA	Respiratory	NA	4E-01	NA	4E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	6E+01	NA	6E+01
	Exposure Medium Total			NA	NA	NA	NA		9E+00	6E+01	1E+00	8E+01
Medium Total				NA	NA	NA	NA		9E+00	6E+01	1E+00	8E+01

TABLE 9.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-01	NA	NA	5E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	9E+00	NA	NA	9E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E+00	NA	NA	2E+00
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	NA	2E+01

TABLE 9.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	NA	9E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	6E-03	NA	NA	6E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+01	NA	NA	3E+01

TABLE 9.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E+00	NA	NA	4E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	NA	9E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-03	NA	NA	8E-03
			Cobalt	NA	NA	NA	NA	Endocrine	5E+01	NA	NA	5E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+01	NA	NA	4E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E+01	NA	NA	1E+01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Vanadium	NA	NA	NA	NA	Dermal	2E+00	NA	NA	2E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		2E+02	NA	NA	2E+02
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-03	1E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Medium Total				NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		3E+02	6E+01	1E+00	3E+02

TABLE 9.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.5	**4**	**5**
Total Dermal HI Across Media =	0.8	**4**	**10**
Total Developmental HI Across Media =	NA	**4**	**5**
Total Endocrine HI Across Media =	**6**	**2**	**56**
Total Gastrointestinal HI Across Media =	0.9	**2**	**42**
Total Hematologic HI Across Media =	0.1	0.05	**34**
Total Hepatic HI Across Media =	NA	0.0002	NA
Total Immune HI Across Media =	0.04	0.04	**24**
Total Nervous HI Across Media =	1	**52**	**28**
Total Not specified HI Across Media =	0.0004	1	0.01
Total Reproductive HI Across Media =	NA	**2**	NA
Total Respiratory HI Across Media =	NA	**16**	NA
Total Urinary HI Across Media =	0.6	0.6	**68**
Total Whole Body HI Across Media =	0.03	0.08	**8**

	Total
Total Cardiovascular HI Across Media =	**9**
Total Dermal HI Across Media =	**15**
Total Developmental HI Across Media =	**9**
Total Endocrine HI Across Media =	**63**
Total Gastrointestinal HI Across Media =	**44**
Total Hematologic HI Across Media =	**34**
Total Hepatic HI Across Media =	0.0002
Total Immune HI Across Media =	**24**
Total Nervous HI Across Media =	**81**
Total Not specified HI Across Media =	1
Total Reproductive HI Across Media =	**2**
Total Respiratory HI Across Media =	**16**
Total Urinary HI Across Media =	**70**
Total Whole Body HI Across Media =	**8**

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	1E-05	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	1E-05	7E-05		NA	NA	NA	NA
	Exposure Medium Total			6E-05	NA	1E-05	7E-05		NA	NA	NA	NA
Medium Total				6E-05	NA	1E-05	7E-05		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-05	NA	8E-06	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	8E-05	NA	6E-04	6E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-04	NA	6E-04	7E-04		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-04	NA	1E-06	2E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	2E-04	NA	8E-05	3E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	8E-05	5E-04		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	9E-05	NA	2E-06	9E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	9E-05	NA	8E-05	2E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-04	NA	9E-05	3E-04		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	1E-04	NA	1E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	5E-06	NA	5E-06	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	4E-03	NA	4E-03	---	NA	NA	NA	NA
			Cobalt	NA	3E-04	NA	3E-04	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	2E-05	NA	2E-05	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	4E-03	NA	4E-03		NA	NA	NA	NA
	Exposure Medium Total			7E-04	4E-03	7E-04	6E-03		NA	NA	NA	NA
Medium Total				7E-04	4E-03	7E-04	6E-03		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	NA	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	NA	7E-05		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-04	NA	NA	4E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	NA	4E-04		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-05	NA	NA	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	NA	3E-05		NA	NA	NA	NA
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	NA	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	NA	6E-05		NA	NA	NA	NA
	Exposure Medium Total			6E-04	NA	NA	6E-04		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-04	NA	NA	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	NA	5E-04		NA	NA	NA	NA

TABLE 9.17.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-07	3E-07		NA	NA	NA	NA
	Exposure Medium Total			5E-04	NA	3E-07	5E-04		NA	NA	NA	NA
Medium Total				1E-03	NA	3E-07	1E-03		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				2E-03	4E-03	8E-04	7E-03		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.18.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	7E-02	NA	NA	7E-02
			Arsenic	1E-05	NA	1E-05	2E-05	Cardiovascular, Dermal	8E-02	NA	2E-02	1E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	5E-03	3E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	6E-05	NA	NA	6E-05
			Cobalt	NA	NA	NA	NA	Endocrine	9E-01	NA	NA	9E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	NA	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-04	NA	NA	1E-04
			Molybdenum	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	NA	1E-02
			Silver	NA	NA	NA	NA	Dermal	6E-03	NA	NA	6E-03
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-03	NA	NA	6E-03
		Exposure Point Total		1E-05	NA	1E-05	2E-05		2E+00	NA	2E-02	2E+00
	Exposure Medium Total			1E-05	NA	1E-05	2E-05		2E+00	NA	2E-02	2E+00
Medium Total				1E-05	NA	1E-05	2E-05		2E+00	NA	2E-02	2E+00

TABLE 9.18.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Aluminum	NA	NA	NA	NA	Nervous	5E-02	NA	1E-02	6E-02
			Arsenic	1E-05	NA	2E-06	1E-05	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	7E-02	NA	1E-02	8E-02
			Barium	NA	NA	NA	NA	Developmental	4E-03	NA	1E-02	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-03	NA	2E-02	2E-02
			Chromium (hexavalent)	9E-06	NA	1E-04	2E-04	Respiratory	2E-02	NA	3E-01	3E-01
			Cobalt	NA	NA	NA	NA	Respiratory	8E-02	NA	7E-03	9E-02
			Copper	NA	NA	NA	NA	NA	2E-03	NA	4E-04	2E-03
			Iron	NA	NA	NA	NA	NA	5E-02	NA	1E-02	7E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-02	NA	3E-01	4E-01
			Molybdenum	NA	NA	NA	NA	NA	9E-04	NA	2E-04	1E-03
			Nickel	NA	NA	NA	NA	Respiratory	3E-03	NA	3E-03	5E-03
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	5E-04	NA	1E-04	7E-04
			Vanadium	NA	NA	NA	NA	Respiratory	6E-03	NA	5E-02	5E-02
			Zinc	NA	NA	NA	NA	NA	1E-03	NA	2E-04	2E-03
		Exposure Point Total		2E-05	NA	2E-04	2E-04		3E-01	NA	7E-01	1E+00
	Exposure Medium Total			2E-05	NA	2E-04	2E-04		3E-01	NA	7E-01	1E+00
Medium Total				2E-05	NA	2E-04	2E-04		3E-01	NA	7E-01	1E+00
Receptor Total (Sediment + Surface Water)				3E-05	NA	2E-04	2E-04		2E+00	NA	7E-01	3E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW
Total Cardiovascular HI Across Media =	0.1	0.08
Total Dermal HI Across Media =	0.1	0.08
Total Developmental HI Across Media =	NA	0.1
Total Endocrine HI Across Media =	0.9	NA
Total Gastrointestinal HI Across Media =	0.1	NA
Total Hematologic HI Across Media =	0.02	NA
Total Hepatic HI Across Media =	NA	0.0007
Total Immune HI Across Media =	0.006	NA
Total Nervous HI Across Media =	0.2	0.5
Total Not specified HI Across Media =	0.00006	NA
Total Reproductive HI Across Media =	NA	0.08
Total Respiratory HI Across Media =	NA	0.5
Total Urinary HI Across Media =	0.1	0.02
Total Whole Body HI Across Media =	0.005	NA

	Total
Total Cardiovascular HI Across Media =	0.2
Total Dermal HI Across Media =	0.2
Total Developmental HI Across Media =	0.1
Total Endocrine HI Across Media =	0.9
Total Gastrointestinal HI Across Media =	0.1
Total Hematologic HI Across Media =	0.02
Total Hepatic HI Across Media =	0.0007
Total Immune HI Across Media =	0.006
Total Nervous HI Across Media =	0.7
Total Not specified HI Across Media =	0.00006
Total Reproductive HI Across Media =	0.08
Total Respiratory HI Across Media =	0.5
Total Urinary HI Across Media =	0.1
Total Whole Body HI Across Media =	0.005

TABLE 9.19.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	2E-03	NA	NA	2E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-03	NA	4E-04	2E-03
			Barium	NA	NA	NA	NA	Urinary	9E-05	NA	NA	9E-05
			Beryllium	NA	NA	NA	NA	Gastrointestinal	6E-05	NA	NA	6E-05
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-04	NA	1E-04	7E-04
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-06	NA	NA	2E-06
			Cobalt	NA	NA	NA	NA	Endocrine	2E-02	NA	NA	2E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-05	NA	NA	4E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	3E-06	NA	NA	3E-06
			Molybdenum	NA	NA	NA	NA	Urinary	2E-03	NA	NA	2E-03
			Nickel	NA	NA	NA	NA	Whole Body	1E-04	NA	NA	1E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-04	NA	NA	3E-04
			Silver	NA	NA	NA	NA	Dermal	2E-04	NA	NA	2E-04
			Vanadium	NA	NA	NA	NA	Dermal	8E-04	NA	NA	8E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-04	NA	NA	2E-04
		Exposure Point Total		NA	NA	NA	NA		4E-02	NA	5E-04	4E-02
	Exposure Medium Total			NA	NA	NA	NA		4E-02	NA	5E-04	4E-02
Medium Total				NA	NA	NA	NA		4E-02	NA	5E-04	4E-02
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	8E-04	NA	2E-04	9E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-03	NA	2E-04	1E-03
			Barium	NA	NA	NA	NA	Urinary	7E-05	NA	2E-04	3E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	7E-05	NA	3E-04	4E-04
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	3E-04	NA	5E-03	5E-03
			Cobalt	NA	NA	NA	NA	Endocrine	1E-03	NA	1E-04	1E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-05	NA	6E-06	3E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-04	NA	2E-04	1E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	9E-04	NA	5E-03	6E-03
			Molybdenum	NA	NA	NA	NA	Urinary	1E-05	NA	3E-06	2E-05
			Nickel	NA	NA	NA	NA	Whole Body	4E-05	NA	4E-05	9E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	9E-06	NA	2E-06	1E-05
			Vanadium	NA	NA	NA	NA	Dermal	9E-05	NA	7E-04	8E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-05	NA	3E-06	3E-05
		Exposure Point Total		NA	NA	NA	NA		6E-03	NA	1E-02	2E-02

TABLE 9.19.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	1E-04	1E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-04	1E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-04	2E-04
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	3E-03	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	7E-05	7E-05
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	4E-06	4E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	1E-04	1E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	3E-03	3E-03
			Molybdenum	NA	NA	NA	NA	Urinary	NA	NA	2E-06	2E-06
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	3E-05	3E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	1E-06	1E-06
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	5E-04	5E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	2E-06	2E-06
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	3E-01	NA	1E-03	3E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-01	NA	2E-03	4E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	2E-03	3E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	3E-03	3E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	9E-02	NA	4E-02	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	1E-03	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	5E-05	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-01	NA	2E-03	3E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	4E-02	4E-01
			Molybdenum	NA	NA	NA	NA	Urinary	5E-03	NA	3E-05	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	4E-04	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	2E-05	3E-03
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	7E-03	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-03	NA	3E-05	8E-03
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		2E+00	NA	1E-01	2E+00

TABLE 9.19.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-01	NA	NA	5E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	NA	9E-02
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-02	NA	NA	3E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	4E-01	NA	NA	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	NA	3E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	NA	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	NA	1E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		3E+00	NA	1E-01	4E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		3E+00	NA	1E-01	4E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.002	0.4	0.09
Total Dermal HI Across Media =	0.003	0.4	0.3
Total Developmental HI Across Media =	NA	NA	0.4
Total Endocrine HI Across Media =	0.02	0.5	0.2
Total Gastrointestinal HI Across Media =	0.004	0.3	0.02
Total Hematologic HI Across Media =	0.0004	0.01	0.7
Total Immune HI Across Media =	0.0002	0.008	0.03
Total Nervous HI Across Media =	0.005	0.6	0.6
Total Not specified HI Across Media =	0.000002	0.1	0.0002
Total Urinary HI Across Media =	0.003	0.06	0.03
Total Whole Body HI Across Media =	0.0001	0.01	0.5

	Total
Total Cardiovascular HI Across Media =	0.5
Total Dermal HI Across Media =	0.7
Total Developmental HI Across Media =	0.4
Total Endocrine HI Across Media =	0.7
Total Gastrointestinal HI Across Media =	0.3
Total Hematologic HI Across Media =	0.7
Total Immune HI Across Media =	0.04
Total Nervous HI Across Media =	1
Total Not specified HI Across Media =	0.1
Total Urinary HI Across Media =	0.09
Total Whole Body HI Across Media =	0.5

TABLE 9.20.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-02	NA	2E-03	2E-02
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-04	NA	NA	7E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-03	NA	6E-04	7E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-05	NA	NA	2E-05
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-04	NA	NA	4E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-02	NA	NA	4E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	3E-05	NA	NA	3E-05
			Molybdenum	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-03	NA	NA	1E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	NA	3E-03
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	NA	2E-03
			Vanadium	NA	NA	NA	NA	Dermal	8E-03	NA	NA	8E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-03	NA	NA	2E-03
		Exposure Point Total		NA	NA	NA	NA		4E-01	NA	3E-03	4E-01
	Exposure Medium Total			NA	NA	NA	NA		4E-01	NA	3E-03	4E-01
Medium Total				NA	NA	NA	NA		4E-01	NA	3E-03	4E-01
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	3E-04	6E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	7E-03	NA	4E-04	8E-03
			Barium	NA	NA	NA	NA	Urinary	5E-04	NA	4E-04	8E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-04	NA	5E-04	1E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-03	NA	8E-03	1E-02
			Cobalt	NA	NA	NA	NA	Endocrine	9E-03	NA	2E-04	1E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-04	NA	1E-05	2E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	6E-03	NA	3E-04	6E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-03	NA	8E-03	1E-02
			Molybdenum	NA	NA	NA	NA	Urinary	1E-04	NA	5E-06	1E-04
			Nickel	NA	NA	NA	NA	Whole Body	3E-04	NA	8E-05	4E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-05	NA	3E-06	6E-05
			Vanadium	NA	NA	NA	NA	Dermal	6E-04	NA	1E-03	2E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-04	NA	5E-06	2E-04
		Exposure Point Total		NA	NA	NA	NA		4E-02	NA	2E-02	6E-02

TABLE 9.20.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	2E-04	2E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	3E-04	3E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	3E-04	3E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	4E-04	4E-04
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	6E-03	6E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	1E-04	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	8E-06	8E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	2E-04	2E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	6E-03	6E-03
			Molybdenum	NA	NA	NA	NA	Urinary	NA	NA	4E-06	4E-06
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	6E-05	6E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	2E-06	2E-06
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	1E-03	1E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	4E-06	4E-06
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	4E-01	NA	2E-03	4E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-01	NA	3E-03	6E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	2E-03	4E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-02	NA	3E-03	4E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-01	NA	5E-02	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	8E-01	NA	1E-03	8E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	7E-05	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-01	NA	2E-03	5E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	6E-02	6E-01
			Molybdenum	NA	NA	NA	NA	Urinary	8E-03	NA	4E-05	8E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	5E-04	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	2E-05	5E-03
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	9E-03	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	3E-05	1E-02
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	1E-01	3E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		3E+00	NA	2E-01	3E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		3E+00	NA	1E-01	3E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		3E+00	NA	2E-01	3E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		3E+00	NA	1E-01	3E+00

TABLE 9.20.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E+00	NA	NA	1E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	NA	2E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-02	NA	NA	8E-02
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
Medium Total				NA	NA	NA	NA		4E+00	NA	NA	4E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		8E+00	NA	2E-01	8E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		7E+00	NA	2E-01	8E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.02	0.6	0.2
Total Dermal HI Across Media =	0.04	0.7	0.7
Total Developmental HI Across Media =	NA	NA	1.1
Total Endocrine HI Across Media =	0.2	0.8	0.5
Total Gastrointestinal HI Across Media =	0.04	0.5	0.05
Total Hematologic HI Across Media =	0.004	0.02	**2**
Total Immune HI Across Media =	0.002	0.01	0.08
Total Nervous HI Across Media =	0.06	1	**2**
Total Not specified HI Across Media =	0.00002	0.2	0.0005
Total Urinary HI Across Media =	0.03	0.09	0.09
Total Whole Body HI Across Media =	0.001	0.02	1

	Total
Total Cardiovascular HI Across Media =	0.9
Total Dermal HI Across Media =	1
Total Developmental HI Across Media =	1
Total Endocrine HI Across Media =	**2**
Total Gastrointestinal HI Across Media =	0.6
Total Hematologic HI Across Media =	**2**
Total Immune HI Across Media =	0.09
Total Nervous HI Across Media =	**3**
Total Not specified HI Across Media =	0.2
Total Urinary HI Across Media =	0.2
Total Whole Body HI Across Media =	1

TABLE 9.21.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	1E-06	NA	1E-07	1E-06	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-06	NA	1E-07	1E-06		NA	NA	NA	NA
	Exposure Medium Total			1E-06	NA	1E-07	1E-06		NA	NA	NA	NA
Medium Total				1E-06	NA	1E-07	1E-06		NA	NA	NA	NA

TABLE 9.21.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-07	NA	4E-08	5E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	1E-06	NA	9E-06	1E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-06	NA	9E-06	1E-05		NA	NA	NA	NA

TABLE 9.21.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-08	3E-08	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	NA	6E-06	6E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	6E-06	6E-06		NA	NA	NA	NA

TABLE 9.21.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	4E-07	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	2E-04	NA	7E-05	3E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-04	NA	7E-05	3E-04		NA	NA	NA	NA
	Exposure Medium Total (Swimming + Potable Use)			3E-04	NA	8E-05	3E-04		NA	NA	NA	NA
	Exposure Medium Total (Wading + Potable Use)			3E-04	NA	8E-05	3E-04		NA	NA	NA	NA
Medium Total (Swimming + Potable Use)				3E-04	NA	8E-05	3E-04		NA	NA	NA	NA
Medium Total (Wading + Potable Use)				3E-04	NA	8E-05	3E-04		NA	NA	NA	NA

TABLE 9.21.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	NA	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-05	NA	NA	2E-05		NA	NA	NA	NA
	Exposure Medium Total			2E-05	NA	NA	2E-05		NA	NA	NA	NA
Medium Total				2E-05	NA	NA	2E-05		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)				3E-04	NA	8E-05	4E-04		NA	NA	NA	NA
Receptor Total (Sediment + Wading + Potable Use + Fish)				3E-04	NA	8E-05	4E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	NA	6E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	NA	4E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	6E-02	3E-01
			Barium	NA	NA	NA	NA	Urinary	5E-03	NA	NA	5E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E-01	NA	1E-01	9E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	4E-01	NA	NA	4E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	NA	5E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	8E-03	NA	NA	8E-03
			Molybdenum	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	NA	1E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	8E-03	NA	NA	8E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	2E-01	3E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+00	NA	2E-01	3E+00
Medium Total				NA	NA	NA	NA		3E+00	NA	2E-01	3E+00

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	9E-03	NA	2E-03	1E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	4E-02	2E-01
			Barium	NA	NA	NA	NA	Urinary	3E-03	NA	8E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	1E-01	1E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	7E-03	NA	1E-01	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	2E-02	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	2E-04	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	4E-03	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-02	NA	3E-01	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	5E-03	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	6E-04	3E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	5E-04	NA	1E-03	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	8E-02	9E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	2E-03	1E-02
		Exposure Point Total		NA	NA	NA	NA		5E-01	NA	7E-01	1E+00

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	5E-02	NA	3E-04	5E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	6E-03	1E+00
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	1E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-02	1E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	4E-02	NA	2E-02	6E-02
			Cobalt	NA	NA	NA	NA	Endocrine	9E-01	NA	2E-03	9E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	6E-03	NA	3E-05	6E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	5E-04	9E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	5E-02	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	7E-04	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	8E-05	1E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	2E-04	3E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	1E-02	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	2E-04	7E-02
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	1E-01	3E+00
		Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	4E-04	2E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-01	NA	8E-03	4E-01
			Barium	NA	NA	NA	NA	Urinary	5E-03	NA	1E-03	7E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-02	NA	2E-02	7E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-02	NA	2E-02	4E-02
			Cobalt	NA	NA	NA	NA	Endocrine	4E-01	NA	3E-03	4E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	4E-05	2E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	7E-04	4E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	7E-02	2E-01
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	1E-03	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-03	NA	1E-04	6E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-03	NA	3E-04	1E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	2E-02	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	3E-04	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	1E-01	1E+00

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	2E+00	NA	2E+00
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	4E+00	NA	4E+00
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+00	NA	1E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	3E+00	NA	3E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	9E+00	NA	9E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	3E+01	NA	3E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	7E-04	NA	7E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	NA	5E-01	NA	5E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	5E+01	NA	5E+01
	Exposure Medium Total			NA	NA	NA	NA		4E+00	5E+01	1E+00	6E+01
Medium Total				NA	NA	NA	NA		4E+00	5E+01	1E+00	6E+01

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-03	NA	NA	7E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	NA	7E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	8E-02	NA	NA	8E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	NA	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	NA	6E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	NA	8E-01
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-02	NA	NA	5E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-01	NA	NA	7E-01
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		7E+00	NA	NA	7E+00

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-02	NA	NA	6E-02
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-02	NA	NA	6E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	NA	5E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-03	NA	NA	2E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-01	NA	NA	6E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	NA	1E+01

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-01	NA	NA	7E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	NA	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	3E-03	NA	NA	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E+01	NA	NA	2E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+01	NA	NA	2E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Vanadium	NA	NA	NA	NA	Dermal	9E-01	NA	NA	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-04	7E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	7E-03	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	7E-03	1E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		1E+02	5E+01	1E+00	2E+02

TABLE 9.22.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.3	**6**	**2**
Total Dermal HI Across Media =	0.4	**6**	**4**
Total Developmental HI Across Media =	NA	**5**	**2**
Total Endocrine HI Across Media =	0.4	**2**	**24**
Total Gastrointestinal HI Across Media =	0.2	0.2	**18**
Total Hematologic HI Across Media =	0.4	0.1	**15**
Total Hepatic HI Across Media =	NA	0.0007	NA
Total Immune HI Across Media =	0.4	0.1	**10**
Total Nervous HI Across Media =	0.5	**38**	**12**
Total Not specified HI Across Media =	0.0002	0.2	0.004
Total Reproductive HI Across Media =	NA	**4**	NA
Total Respiratory HI Across Media =	NA	**17**	NA
Total Urinary HI Across Media =	1	**2**	**29**
Total Whole Body HI Across Media =	0.04	0.05	**4**

	Total
Total Cardiovascular HI Across Media =	**8**
Total Dermal HI Across Media =	**11**
Total Developmental HI Across Media =	**7**
Total Endocrine HI Across Media =	**26**
Total Gastrointestinal HI Across Media =	**18**
Total Hematologic HI Across Media =	**15**
Total Hepatic HI Across Media =	0.0007
Total Immune HI Across Media =	**11**
Total Nervous HI Across Media =	**51**
Total Not specified HI Across Media =	0.2
Total Reproductive HI Across Media =	**4**
Total Respiratory HI Across Media =	**17**
Total Urinary HI Across Media =	**32**
Total Whole Body HI Across Media =	**4**

TABLE 9.23.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	3E-01	NA	NA	3E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	NA	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	9E-02	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+00	NA	2E-01	4E+00
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E+00	NA	NA	2E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E+00	NA	NA	1E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	4E-02	NA	NA	4E-02
			Molybdenum	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	4E-02	NA	NA	4E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		1E+01	NA	3E-01	1E+01
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	3E-01	1E+01
Medium Total				NA	NA	NA	NA		1E+01	NA	3E-01	1E+01

TABLE 9.23.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	4E-02	NA	2E-03	5E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-01	NA	5E-02	9E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	9E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-01	2E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	3E-02	NA	1E-01	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	8E-01	NA	2E-02	8E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	3E-04	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	4E-03	8E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	4E-01	7E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	6E-03	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	7E-04	1E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	2E-03	4E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	9E-02	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-02	NA	2E-03	6E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	8E-01	3E+00
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	7E-02	NA	3E-04	7E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	6E-03	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	2E-02	2E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	6E-02	NA	2E-02	8E-02
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	2E-03	1E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	4E-05	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	6E-04	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	5E-02	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	8E-04	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-02	NA	9E-05	2E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	4E-03	NA	2E-04	4E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	8E-02	NA	1E-02	9E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	3E-04	1E-01
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	1E-01	4E+00

TABLE 9.23.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	9E-02	NA	6E-04	9E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	1E-02	2E+00
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	2E-03	3E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	3E-02	3E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	7E-02	NA	4E-02	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E+00	NA	4E-03	2E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	7E-05	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	1E-03	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-01	NA	1E-01	7E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-02	NA	2E-03	5E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-02	NA	2E-04	3E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	5E-03	NA	4E-04	5E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	2E-02	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	5E-04	1E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	2E-01	5E+00
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	2E+00	NA	2E+00
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	4E+00	NA	4E+00
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+00	NA	1E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	3E+00	NA	3E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	9E+00	NA	9E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	3E+01	NA	3E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	7E-04	NA	7E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	NA	5E-01	NA	5E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	5E+01	NA	5E+01
	Exposure Medium Total			NA	NA	NA	NA		1E+01	5E+01	1E+00	7E+01
Medium Total				NA	NA	NA	NA		1E+01	5E+01	1E+00	7E+01

TABLE 9.23.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-01	NA	NA	5E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	9E+00	NA	NA	9E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E+00	NA	NA	2E+00
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	NA	2E+01

TABLE 9.23.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Exposure Point Total	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	NA	9E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
		Semi-Aquatic Mammals Tissue Exposure Point Total	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	6E-03	NA	NA	6E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+01	NA	NA	3E+01

TABLE 9.23.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E+00	NA	NA	4E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	NA	9E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-03	NA	NA	8E-03
			Cobalt	NA	NA	NA	NA	Endocrine	5E+01	NA	NA	5E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+01	NA	NA	4E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E+01	NA	NA	1E+01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Vanadium	NA	NA	NA	NA	Dermal	2E+00	NA	NA	2E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		2E+02	NA	NA	2E+02
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-03	1E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Medium Total				NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		3E+02	5E+01	1E+00	3E+02

TABLE 9.23.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	1	**8**	**5**
Total Dermal HI Across Media =	1	**9**	**10**
Total Developmental HI Across Media =	NA	**5**	**5**
Total Endocrine HI Across Media =	**2**	**4**	**56**
Total Gastrointestinal HI Across Media =	1	0.4	**42**
Total Hematologic HI Across Media =	**2**	0.4	**34**
Total Hepatic HI Across Media =	NA	0.0007	NA
Total Immune HI Across Media =	**2**	0.3	**24**
Total Nervous HI Across Media =	**2**	**39**	**28**
Total Not specified HI Across Media =	0.0009	0.4	0.01
Total Reproductive HI Across Media =	NA	**4**	NA
Total Respiratory HI Across Media =	NA	**17**	NA
Total Urinary HI Across Media =	**4**	**2**	**68**
Total Whole Body HI Across Media =	0.2	0.1	**8**

	Total
Total Cardiovascular HI Across Media =	**14**
Total Dermal HI Across Media =	**21**
Total Developmental HI Across Media =	**10**
Total Endocrine HI Across Media =	**61**
Total Gastrointestinal HI Across Media =	**43**
Total Hematologic HI Across Media =	**36**
Total Hepatic HI Across Media =	0.0007
Total Immune HI Across Media =	**26**
Total Nervous HI Across Media =	**70**
Total Not specified HI Across Media =	0.4
Total Reproductive HI Across Media =	**4**
Total Respiratory HI Across Media =	**17**
Total Urinary HI Across Media =	**75**
Total Whole Body HI Across Media =	**9**

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	1E-04	NA	3E-05	2E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-04	NA	3E-05	2E-04		NA	NA	NA	NA
	Exposure Medium Total			1E-04	NA	3E-05	2E-04		NA	NA	NA	NA
Medium Total				1E-04	NA	3E-05	2E-04		NA	NA	NA	NA

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	1E-04	NA	2E-05	1E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	3E-05	NA	2E-04	2E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-04	NA	2E-04	4E-04		NA	NA	NA	NA

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-04	NA	3E-06	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	7E-05	NA	3E-05	1E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	3E-05	6E-04		NA	NA	NA	NA

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-04	NA	4E-06	2E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	3E-05	NA	3E-05	6E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-04	NA	3E-05	3E-04		NA	NA	NA	NA

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	2E-04	NA	2E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	2E-05	NA	2E-05	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	1E-03	NA	1E-03	---	NA	NA	NA	NA
			Cobalt	NA	5E-04	NA	5E-04	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	3E-05	NA	3E-05	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	2E-03	NA	2E-03		NA	NA	NA	NA
	Exposure Medium Total			9E-04	2E-03	3E-04	3E-03		NA	NA	NA	NA
Medium Total				9E-04	2E-03	3E-04	3E-03		NA	NA	NA	NA

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	NA	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	NA	7E-05		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-04	NA	NA	4E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	NA	4E-04		NA	NA	NA	NA

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-05	NA	NA	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	NA	3E-05		NA	NA	NA	NA
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	NA	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	NA	6E-05		NA	NA	NA	NA
	Exposure Medium Total			6E-04	NA	NA	6E-04		NA	NA	NA	NA

TABLE 9.24.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-04	NA	NA	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	NA	5E-04		NA	NA	NA	NA
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-07	3E-07		NA	NA	NA	NA
	Exposure Medium Total			5E-04	NA	3E-07	5E-04		NA	NA	NA	NA
Medium Total				1E-03	NA	3E-07	1E-03		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				2E-03	2E-03	3E-04	5E-03		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.25.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	5E-02	NA	NA	5E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	3E-02	NA	NA	3E-02
			Arsenic	3E-05	NA	3E-05	6E-05	Cardiovascular, Dermal	2E-01	NA	5E-02	2E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	1E-01	7E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Cobalt	NA	NA	NA	NA	Endocrine	3E-01	NA	NA	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	NA	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-01	NA	NA	4E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	6E-03	NA	NA	6E-03
			Molybdenum	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	7E-03	NA	NA	7E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	NA	1E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-03	NA	NA	6E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		3E-05	NA	3E-05	6E-05		2E+00	NA	2E-01	2E+00
	Exposure Medium Total			3E-05	NA	3E-05	6E-05		2E+00	NA	2E-01	2E+00
Medium Total				3E-05	NA	3E-05	6E-05		2E+00	NA	2E-01	2E+00

TABLE 9.25.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Aluminum	NA	NA	NA	NA	Nervous	8E-03	NA	2E-03	9E-03
			Arsenic	2E-05	NA	5E-06	3E-05	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	2E-01	NA	3E-02	2E-01
			Barium	NA	NA	NA	NA	Developmental	2E-03	NA	6E-03	8E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	8E-02	1E-01
			Chromium (hexavalent)	3E-06	NA	5E-05	6E-05	Respiratory	6E-03	NA	1E-01	1E-01
			Cobalt	NA	NA	NA	NA	Respiratory	1E-01	NA	1E-02	2E-01
			Copper	NA	NA	NA	NA	NA	9E-04	NA	2E-04	1E-03
			Iron	NA	NA	NA	NA	NA	1E-02	NA	3E-03	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-02	NA	3E-01	3E-01
			Nickel	NA	NA	NA	NA	Respiratory	4E-03	NA	4E-03	8E-03
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	2E-03	NA	5E-04	3E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	NA	4E-04	NA	1E-03	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	8E-03	NA	7E-02	7E-02
			Zinc	NA	NA	NA	NA	NA	1E-02	NA	1E-03	1E-02
		Exposure Point Total		3E-05	NA	6E-05	9E-05		4E-01	NA	6E-01	1E+00
	Exposure Medium Total			3E-05	NA	6E-05	9E-05		4E-01	NA	6E-01	1E+00
Medium Total				3E-05	NA	6E-05	9E-05		4E-01	NA	6E-01	1E+00
Receptor Total (Sediment + Surface Water)				6E-05	NA	9E-05	1E-04		3E+00	NA	7E-01	3E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW
Total Cardiovascular HI Across Media =	0.2	0.2
Total Dermal HI Across Media =	0.3	0.2
Total Developmental HI Across Media =	NA	0.2
Total Endocrine HI Across Media =	0.3	NA
Total Gastrointestinal HI Across Media =	0.2	NA
Total Hematologic HI Across Media =	0.4	NA
Total Hepatic HI Across Media =	NA	0.003
Total Immune HI Across Media =	0.3	NA
Total Nervous HI Across Media =	0.4	0.5
Total Not specified HI Across Media =	0.0001	NA
Total Reproductive HI Across Media =	NA	0.2
Total Respiratory HI Across Media =	NA	0.5
Total Urinary HI Across Media =	0.8	0.1
Total Whole Body HI Across Media =	0.04	NA

	Total
Total Cardiovascular HI Across Media =	0.4
Total Dermal HI Across Media =	0.5
Total Developmental HI Across Media =	0.2
Total Endocrine HI Across Media =	0.3
Total Gastrointestinal HI Across Media =	0.2
Total Hematologic HI Across Media =	0.4
Total Hepatic HI Across Media =	0.003
Total Immune HI Across Media =	0.3
Total Nervous HI Across Media =	0.9
Total Not specified HI Across Media =	0.0001
Total Reproductive HI Across Media =	0.2
Total Respiratory HI Across Media =	0.5
Total Urinary HI Across Media =	0.9
Total Whole Body HI Across Media =	0.04

TABLE 9.26.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	7E-04	NA	NA	7E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	5E-03	NA	1E-03	6E-03
			Barium	NA	NA	NA	NA	Urinary	9E-05	NA	NA	9E-05
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-05	NA	NA	5E-05
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-02	NA	2E-03	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-06	NA	NA	4E-06
			Cobalt	NA	NA	NA	NA	Endocrine	7E-03	NA	NA	7E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-05	NA	NA	4E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	9E-03	NA	NA	9E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-04	NA	NA	1E-04
			Molybdenum	NA	NA	NA	NA	Urinary	2E-03	NA	NA	2E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-04	NA	NA	2E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-04	NA	NA	3E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-04	NA	NA	2E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-04	NA	NA	6E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-03	NA	NA	8E-03
		Exposure Point Total		NA	NA	NA	NA		5E-02	NA	3E-03	6E-02
	Exposure Medium Total			NA	NA	NA	NA		5E-02	NA	3E-03	6E-02
Medium Total				NA	NA	NA	NA		5E-02	NA	3E-03	6E-02

TABLE 9.26.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	1E-04	NA	3E-05	2E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-03	NA	5E-04	3E-03
			Barium	NA	NA	NA	NA	Urinary	3E-05	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	3E-04	NA	1E-03	2E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	1E-04	NA	2E-03	2E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E-03	NA	2E-04	3E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-05	NA	3E-06	2E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-04	NA	5E-05	3E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	8E-04	NA	4E-03	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	6E-05	NA	7E-05	1E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-05	NA	8E-06	4E-05
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-06	NA	2E-05	3E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-04	NA	1E-03	1E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-04	NA	2E-05	2E-04
		Exposure Point Total		NA	NA	NA	NA		7E-03	NA	1E-02	2E-02
		Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	2E-05	2E-05
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	3E-04	3E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	6E-05	6E-05
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	8E-04	8E-04
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	1E-03	1E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	1E-04	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	2E-06	2E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	3E-05	3E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	3E-03	3E-03
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	4E-05	4E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	5E-06	5E-06
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	NA	NA	1E-05	1E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	7E-04	7E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	1E-05	1E-05
		Exposure Point Total		NA	NA	NA	NA		NA	NA	6E-03	6E-03

TABLE 9.26.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	4E-02	NA	2E-04	4E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	5E-03	8E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	9E-04	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-02	1E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	3E-02	NA	1E-02	5E-02
			Cobalt	NA	NA	NA	NA	Endocrine	8E-01	NA	2E-03	8E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	3E-05	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	4E-04	8E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	4E-02	3E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	6E-04	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-02	NA	7E-05	1E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	2E-04	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	4E-02	NA	9E-03	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-02	NA	2E-04	6E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	8E-02	2E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		2E+00	NA	9E-02	2E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		2E+00	NA	9E-02	2E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		2E+00	NA	9E-02	2E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		2E+00	NA	9E-02	2E+00

TABLE 9.26.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-01	NA	NA	5E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	NA	9E-02
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-02	NA	NA	3E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	4E-01	NA	NA	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	NA	3E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	NA	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	NA	1E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		4E+00	NA	1E-01	4E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		4E+00	NA	9E-02	4E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.006	0.8	0.09
Total Dermal HI Across Media =	0.007	0.9	0.3
Total Developmental HI Across Media =	NA	NA	0.4
Total Endocrine HI Across Media =	0.007	0.8	0.2
Total Gastrointestinal HI Across Media =	0.005	0.08	0.02
Total Hematologic HI Across Media =	0.009	0.07	0.7
Total Immune HI Across Media =	0.008	0.06	0.03
Total Nervous HI Across Media =	0.01	0.4	0.6
Total Not specified HI Across Media =	0.000004	0.05	0.0002
Total Urinary HI Across Media =	0.02	0.1	0.03
Total Whole Body HI Across Media =	0.0009	0.02	0.5

	Total
Total Cardiovascular HI Across Media =	0.9
Total Dermal HI Across Media =	1
Total Developmental HI Across Media =	0.4
Total Endocrine HI Across Media =	1
Total Gastrointestinal HI Across Media =	0.1
Total Hematologic HI Across Media =	0.8
Total Immune HI Across Media =	0.1
Total Nervous HI Across Media =	1
Total Not specified HI Across Media =	0.05
Total Urinary HI Across Media =	0.2
Total Whole Body HI Across Media =	0.5

TABLE 9.27.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-03	NA	NA	8E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	5E-02	NA	6E-03	6E-02
			Barium	NA	NA	NA	NA	Urinary	9E-04	NA	NA	9E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	6E-04	NA	NA	6E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	1E-02	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-05	NA	NA	4E-05
			Cobalt	NA	NA	NA	NA	Endocrine	8E-02	NA	NA	8E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-04	NA	NA	4E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-03	NA	NA	2E-03
			Molybdenum	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	NA	3E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	NA	2E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	7E-03	NA	NA	7E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-02	NA	NA	8E-02
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	2E-02	6E-01
	Exposure Medium Total			NA	NA	NA	NA		6E-01	NA	2E-02	6E-01
Medium Total				NA	NA	NA	NA		6E-01	NA	2E-02	6E-01

TABLE 9.27.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	9E-04	NA	5E-05	9E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-02	NA	9E-04	2E-02
			Barium	NA	NA	NA	NA	Urinary	2E-04	NA	2E-04	4E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-03	NA	2E-03	5E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	7E-04	NA	3E-03	4E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E-02	NA	3E-04	2E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-04	NA	5E-06	1E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	8E-05	2E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-03	NA	8E-03	1E-02
			Nickel	NA	NA	NA	NA	Whole Body	4E-04	NA	1E-04	6E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-04	NA	1E-05	3E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	4E-05	NA	3E-05	7E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	9E-04	NA	2E-03	3E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-03	NA	4E-05	1E-03
		Exposure Point Total		NA	NA	NA	NA		5E-02	NA	2E-02	6E-02
		Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	3E-05	3E-05
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-04	7E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-03	2E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	2E-03	2E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	3E-04	3E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	4E-06	4E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	6E-05	6E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	6E-03	6E-03
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	9E-05	9E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	1E-05	1E-05
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	NA	NA	2E-05	2E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	1E-03	1E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	3E-05	3E-05
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02

TABLE 9.27.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	7E-02	NA	3E-04	7E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	6E-03	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	2E-02	2E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	5E-02	NA	2E-02	7E-02
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	2E-03	1E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	3E-05	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	6E-04	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	5E-02	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	8E-04	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-02	NA	9E-05	2E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	3E-03	NA	2E-04	4E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	7E-02	NA	1E-02	9E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	3E-04	1E-01
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	1E-01	4E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		4E+00	NA	1E-01	4E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		4E+00	NA	1E-01	4E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		4E+00	NA	1E-01	4E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		4E+00	NA	1E-01	4E+00

TABLE 9.27.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E+00	NA	NA	1E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	NA	2E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-02	NA	NA	8E-02
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
Medium Total				NA	NA	NA	NA		4E+00	NA	NA	4E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		8E+00	NA	1E-01	9E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		8E+00	NA	1E-01	8E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.06	1	0.2
Total Dermal HI Across Media =	0.07	**2**	0.7
Total Developmental HI Across Media =	NA	NA	1
Total Endocrine HI Across Media =	0.08	1	0.5
Total Gastrointestinal HI Across Media =	0.05	0.1	0.05
Total Hematologic HI Across Media =	0.09	0.1	**2**
Total Immune HI Across Media =	0.08	0.1	0.08
Total Nervous HI Across Media =	0.1	0.6	**2**
Total Not specified HI Across Media =	0.00004	0.08	0.0005
Total Urinary HI Across Media =	0.2	0.2	0.09
Total Whole Body HI Across Media =	0.009	0.04	1

	Total
Total Cardiovascular HI Across Media =	**2**
Total Dermal HI Across Media =	**2**
Total Developmental HI Across Media =	1
Total Endocrine HI Across Media =	**2**
Total Gastrointestinal HI Across Media =	0.2
Total Hematologic HI Across Media =	**2**
Total Immune HI Across Media =	0.3
Total Nervous HI Across Media =	**2**
Total Not specified HI Across Media =	0.08
Total Urinary HI Across Media =	0.5
Total Whole Body HI Across Media =	1

TABLE 9.28.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-06	NA	4E-07	3E-06	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-06	NA	4E-07	3E-06		NA	NA	NA	NA
	Exposure Medium Total			3E-06	NA	4E-07	3E-06		NA	NA	NA	NA
Medium Total				3E-06	NA	4E-07	3E-06		NA	NA	NA	NA

TABLE 9.28.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	1E-06	NA	1E-07	1E-06	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	5E-07	NA	3E-06	4E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-06	NA	3E-06	5E-06		NA	NA	NA	NA

TABLE 9.28.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	7E-08	7E-08	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	NA	2E-06	2E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	2E-06	2E-06		NA	NA	NA	NA

TABLE 9.28.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-04	NA	8E-07	2E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	7E-05	NA	3E-05	9E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-04	NA	3E-05	3E-04		NA	NA	NA	NA
	Exposure Medium Total (Swimming + Potable Use)			2E-04	NA	3E-05	3E-04		NA	NA	NA	NA
	Exposure Medium Total (Wading + Potable Use)			2E-04	NA	3E-05	3E-04		NA	NA	NA	NA
Medium Total (Swimming + Potable Use)				2E-04	NA	3E-05	3E-04		NA	NA	NA	NA
Medium Total (Wading + Potable Use)				2E-04	NA	3E-05	3E-04		NA	NA	NA	NA

TABLE 9.28.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	NA	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-05	NA	NA	2E-05		NA	NA	NA	NA
	Exposure Medium Total			2E-05	NA	NA	2E-05		NA	NA	NA	NA
Medium Total				2E-05	NA	NA	2E-05		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)				3E-04	NA	3E-05	3E-04		NA	NA	NA	NA
Receptor Total (Sediment + Wading + Potable Use + Fish)				3E-04	NA	3E-05	3E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.29.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	7E-02	NA	NA	7E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	NA	4E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	5E-02	NA	1E-02	6E-02
			Barium	NA	NA	NA	NA	Urinary	3E-03	NA	NA	3E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E-02	NA	1E-02	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	NA	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	NA	5E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	4E-03	NA	NA	4E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-03	NA	NA	4E-03
			Silver	NA	NA	NA	NA	Dermal	1E-03	NA	NA	1E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	2E-02	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	2E-02	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	2E-02	1E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	2E-03	NA	5E-04	3E-03
			Barium	NA	NA	NA	NA	Urinary	2E-03	NA	7E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-04	NA	2E-03	3E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	2E-03	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	7E-04	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-02	NA	2E-01	2E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-04	NA	6E-04	1E-03
			Vanadium	NA	NA	NA	NA	Dermal	5E-04	NA	4E-03	5E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-03	NA	1E-04	1E-03
		Exposure Point Total		NA	NA	NA	NA		5E-02	NA	2E-01	3E-01

TABLE 9.29.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	7E-05	1E-02
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	1E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	3E-03	NA	3E-04	3E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	2E-04	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	9E-05	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	3E-02	2E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	9E-05	3E-03
			Vanadium	NA	NA	NA	NA	Dermal	3E-03	NA	6E-04	3E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	5E-03	NA	2E-05	5E-03
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	3E-02	3E-01
		Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	1E-04	5E-03
			Barium	NA	NA	NA	NA	Urinary	5E-03	NA	1E-03	7E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-03	NA	4E-04	1E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	4E-04	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	6E-03	NA	1E-04	7E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	7E-02	NA	4E-02	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	1E-03	NA	1E-04	1E-03
			Vanadium	NA	NA	NA	NA	Dermal	1E-03	NA	9E-04	2E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-03	NA	3E-05	2E-03
		Exposure Point Total		NA	NA	NA	NA		1E-01	NA	4E-02	2E-01
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	5E-01	NA	5E-01
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E-02	NA	3E-02
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	2E+01	NA	2E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E-01	NA	1E-01
			Vanadium	NA	NA	NA	NA	Respiratory	NA	3E-02	NA	3E-02
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	2E+01	NA	2E+01
	Exposure Medium Total			NA	NA	NA	NA		4E-01	2E+01	3E-01	2E+01
Medium Total				NA	NA	NA	NA		4E-01	2E+01	3E-01	2E+01

TABLE 9.29.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-03	NA	NA	7E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	NA	7E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	8E-02	NA	NA	8E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	NA	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	NA	6E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	NA	8E-01
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-02	NA	NA	5E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-01	NA	NA	7E-01
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		7E+00	NA	NA	7E+00

TABLE 9.29.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-02	NA	NA	6E-02
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-02	NA	NA	6E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	NA	5E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-03	NA	NA	2E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-01	NA	NA	6E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	NA	1E+01

TABLE 9.29.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-01	NA	NA	7E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	NA	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	3E-03	NA	NA	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E+01	NA	NA	2E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+01	NA	NA	2E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Vanadium	NA	NA	NA	NA	Dermal	9E-01	NA	NA	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-04	7E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	7E-03	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	7E-03	1E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		1E+02	2E+01	3E-01	1E+02

TABLE 9.29.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.06	NA	**2**
Total Dermal HI Across Media =	0.09	0.01	**4**
Total Developmental HI Across Media =	NA	1	**2**
Total Endocrine HI Across Media =	0.2	NA	**24**
Total Gastrointestinal HI Across Media =	0.1	0.1	**18**
Total Hematologic HI Across Media =	0.08	0.009	**15**
Total Immune HI Across Media =	0.05	0.009	**10**
Total Nervous HI Across Media =	0.6	**18**	**12**
Total Not specified HI Across Media =	0.0001	NA	0.004
Total Reproductive HI Across Media =	NA	NA	NA
Total Respiratory HI Across Media =	NA	0.2	NA
Total Urinary HI Across Media =	0.1	0.06	**29**
Total Whole Body HI Across Media =	0.05	0.006	**4**

	Total
Total Cardiovascular HI Across Media =	**2**
Total Dermal HI Across Media =	**5**
Total Developmental HI Across Media =	**3**
Total Endocrine HI Across Media =	**24**
Total Gastrointestinal HI Across Media =	**18**
Total Hematologic HI Across Media =	**15**
Total Immune HI Across Media =	**10**
Total Nervous HI Across Media =	**30**
Total Not specified HI Across Media =	0.004
Total Reproductive HI Across Media =	NA
Total Respiratory HI Across Media =	0.2
Total Urinary HI Across Media =	**30**
Total Whole Body HI Across Media =	**4**

TABLE 9.30.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	3E-01	NA	NA	3E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	NA	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	2E-02	2E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	NA	1E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	NA	9E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	2E-02	3E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	7E-01	NA	NA	7E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	6E-03	NA	NA	6E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-01	NA	NA	5E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-02	NA	NA	2E-02
			Silver	NA	NA	NA	NA	Dermal	5E-03	NA	NA	5E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	4E-02	5E+00
	Exposure Medium Total			NA	NA	NA	NA		5E+00	NA	4E-02	5E+00
Medium Total				NA	NA	NA	NA		5E+00	NA	4E-02	5E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	6E-04	1E-02
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	8E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-03	NA	2E-03	5E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	2E-03	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	7E-04	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	2E-01	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	7E-04	4E-03
			Vanadium	NA	NA	NA	NA	Dermal	2E-03	NA	5E-03	7E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	5E-03	NA	1E-04	5E-03
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	2E-01	5E-01

TABLE 9.30.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	8E-05	2E-02
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-03	NA	3E-04	4E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	7E-02	NA	3E-04	7E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	1E-04	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	3E-02	3E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	1E-04	5E-03
			Vanadium	NA	NA	NA	NA	Dermal	4E-03	NA	7E-04	5E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-03	NA	2E-05	8E-03
		Exposure Point Total		NA	NA	NA	NA		4E-01	NA	3E-02	4E-01
		Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	2E-04	2E-02
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	2E-03	3E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-03	NA	6E-04	5E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	5E-04	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	2E-04	3E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	5E-02	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	2E-04	6E-03
			Vanadium	NA	NA	NA	NA	Dermal	5E-03	NA	1E-03	7E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	4E-05	1E-02
		Exposure Point Total		NA	NA	NA	NA		5E-01	NA	6E-02	6E-01
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	5E-01	NA	5E-01
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E-02	NA	3E-02
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	2E+01	NA	2E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E-01	NA	1E-01
			Vanadium	NA	NA	NA	NA	Respiratory	NA	3E-02	NA	3E-02
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	2E+01	NA	2E+01
	Exposure Medium Total			NA	NA	NA	NA		1E+00	2E+01	3E-01	2E+01
Medium Total				NA	NA	NA	NA		1E+00	2E+01	3E-01	2E+01

TABLE 9.30.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-01	NA	NA	5E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	9E+00	NA	NA	9E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E+00	NA	NA	2E+00
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	NA	2E+01

TABLE 9.30.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	NA	9E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	6E-03	NA	NA	6E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+01	NA	NA	3E+01

TABLE 9.30.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E+00	NA	NA	4E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	NA	9E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-03	NA	NA	8E-03
			Cobalt	NA	NA	NA	NA	Endocrine	5E+01	NA	NA	5E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+01	NA	NA	4E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E+01	NA	NA	1E+01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Vanadium	NA	NA	NA	NA	Dermal	2E+00	NA	NA	2E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		2E+02	NA	NA	2E+02
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-03	1E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Medium Total				NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		2E+02	2E+01	4E-01	3E+02

TABLE 9.30.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.2	NA	**5**
Total Dermal HI Across Media =	0.4	0.02	**10**
Total Developmental HI Across Media =	NA	1	**5**
Total Endocrine HI Across Media =	0.7	NA	**56**
Total Gastrointestinal HI Across Media =	0.6	0.3	**42**
Total Hematologic HI Across Media =	0.4	0.02	**34**
Total Immune HI Across Media =	0.3	0.02	**24**
Total Nervous HI Across Media =	**3**	**18**	**28**
Total Not specified HI Across Media =	0.0005	NA	0.01
Total Reproductive HI Across Media =	NA	NA	NA
Total Respiratory HI Across Media =	NA	0.2	NA
Total Urinary HI Across Media =	0.5	0.1	**68**
Total Whole Body HI Across Media =	0.2	0.01	**8**

	Total
Total Cardiovascular HI Across Media =	**5**
Total Dermal HI Across Media =	**11**
Total Developmental HI Across Media =	**6**
Total Endocrine HI Across Media =	**56**
Total Gastrointestinal HI Across Media =	**42**
Total Hematologic HI Across Media =	**34**
Total Immune HI Across Media =	**24**
Total Nervous HI Across Media =	**49**
Total Not specified HI Across Media =	0.01
Total Reproductive HI Across Media =	NA
Total Respiratory HI Across Media =	0.2
Total Urinary HI Across Media =	**69**
Total Whole Body HI Across Media =	**9**

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-05	NA	5E-06	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	5E-06	3E-05		NA	NA	NA	NA
	Exposure Medium Total			3E-05	NA	5E-06	3E-05		NA	NA	NA	NA
Medium Total				3E-05	NA	5E-06	3E-05		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	4E-07	NA	4E-07	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	3E-06	NA	3E-06	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	4E-06	NA	4E-06		NA	NA	NA	NA
	Exposure Medium Total			0E+00	4E-06	0E+00	4E-06		NA	NA	NA	NA
Medium Total				0E+00	4E-06	0E+00	4E-06		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	NA	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	NA	7E-05		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-04	NA	NA	4E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	NA	4E-04		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-05	NA	NA	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	NA	3E-05		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	NA	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	NA	6E-05		NA	NA	NA	NA
	Exposure Medium Total			6E-04	NA	NA	6E-04		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-04	NA	NA	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	NA	5E-04		NA	NA	NA	NA

TABLE 9.31.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-07	3E-07		NA	NA	NA	NA
	Exposure Medium Total			5E-04	NA	3E-07	5E-04		NA	NA	NA	NA
Medium Total				1E-03	NA	3E-07	1E-03		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				1E-03	4E-06	6E-06	1E-03		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.32.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	5E-02	NA	NA	5E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	NA	4E-02
			Arsenic	6E-06	NA	5E-06	1E-05	Cardiovascular, Dermal	4E-02	NA	9E-03	4E-02
			Barium	NA	NA	NA	NA	Urinary	3E-03	NA	NA	3E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-02	NA	1E-02	7E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-05	NA	NA	9E-05
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	NA	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	NA	9E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-01	NA	NA	4E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	NA	3E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	NA	3E-03
			Silver	NA	NA	NA	NA	Dermal	9E-04	NA	NA	9E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	NA	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		6E-06	NA	5E-06	1E-05		9E-01	NA	2E-02	9E-01
	Exposure Medium Total			6E-06	NA	5E-06	1E-05		9E-01	NA	2E-02	9E-01
Medium Total				6E-06	NA	5E-06	1E-05		9E-01	NA	2E-02	9E-01
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Aluminum	NA	NA	NA	NA	Nervous	2E-03	NA	4E-04	2E-03
			Barium	NA	NA	NA	NA	Developmental	2E-03	NA	6E-03	8E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-04	NA	2E-03	2E-03
			Copper	NA	NA	NA	NA	NA	7E-03	NA	1E-03	8E-03
			Iron	NA	NA	NA	NA	NA	2E-03	NA	5E-04	3E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-02	NA	1E-01	2E-01
			Nickel	NA	NA	NA	NA	Respiratory	5E-04	NA	5E-04	1E-03
			Vanadium	NA	NA	NA	NA	Respiratory	4E-04	NA	4E-03	4E-03
			Zinc	NA	NA	NA	NA	NA	8E-04	NA	1E-04	9E-04
		Exposure Point Total		0E+00	NA	NA	0E+00		4E-02	NA	2E-01	2E-01
	Exposure Medium Total			0E+00	NA	NA	0E+00		4E-02	NA	2E-01	2E-01
Medium Total				0E+00	NA	NA	0E+00		4E-02	NA	2E-01	2E-01
Receptor Total (Sediment + Surface Water)				6E-06	NA	5E-06	1E-05		9E-01	NA	2E-01	1E+00

TABLE 9.32.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW
Total Cardiovascular HI Across Media =	0.04	NA
Total Dermal HI Across Media =	0.07	NA
Total Developmental HI Across Media =	NA	0.008
Total Endocrine HI Across Media =	0.1	NA
Total Gastrointestinal HI Across Media =	0.1	NA
Total Hematologic HI Across Media =	0.06	NA
Total Immune HI Across Media =	0.04	NA
Total Nervous HI Across Media =	0.5	0.2
Total Not specified HI Across Media =	0.00009	NA
Total Respiratory HI Across Media =	NA	0.005
Total Urinary HI Across Media =	0.09	0.002
Total Whole Body HI Across Media =	0.04	NA

	Total
Total Cardiovascular HI Across Media =	0.04
Total Dermal HI Across Media =	0.07
Total Developmental HI Across Media =	0.008
Total Endocrine HI Across Media =	0.1
Total Gastrointestinal HI Across Media =	0.1
Total Hematologic HI Across Media =	0.06
Total Immune HI Across Media =	0.04
Total Nervous HI Across Media =	0.7
Total Not specified HI Across Media =	0.00009
Total Respiratory HI Across Media =	0.005
Total Urinary HI Across Media =	0.09
Total Whole Body HI Across Media =	0.04

TABLE 9.33.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	9E-04	NA	NA	9E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-04	NA	2E-04	1E-03
			Barium	NA	NA	NA	NA	Urinary	6E-05	NA	NA	6E-05
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-05	NA	NA	4E-05
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-03	NA	2E-04	2E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-06	NA	NA	2E-06
			Cobalt	NA	NA	NA	NA	Endocrine	3E-03	NA	NA	3E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-05	NA	NA	3E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	4E-04	NA	NA	4E-04
			Nickel	NA	NA	NA	NA	Whole Body	7E-05	NA	NA	7E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-05	NA	NA	7E-05
			Silver	NA	NA	NA	NA	Dermal	2E-05	NA	NA	2E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-04	NA	NA	6E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-04	NA	NA	6E-04
		Exposure Point Total		NA	NA	NA	NA		2E-02	NA	4E-04	2E-02
	Exposure Medium Total			NA	NA	NA	NA		2E-02	NA	4E-04	2E-02
Medium Total				NA	NA	NA	NA		2E-02	NA	4E-04	2E-02
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	3E-05	NA	7E-06	4E-05
			Barium	NA	NA	NA	NA	Urinary	3E-05	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	6E-06	NA	3E-05	3E-05
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-04	NA	2E-05	1E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-05	NA	9E-06	5E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-04	NA	2E-03	3E-03
			Nickel	NA	NA	NA	NA	Whole Body	8E-06	NA	8E-06	2E-05
			Vanadium	NA	NA	NA	NA	Dermal	7E-06	NA	6E-05	7E-05
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-05	NA	2E-06	2E-05
		Exposure Point Total		NA	NA	NA	NA		7E-04	NA	3E-03	3E-03

TABLE 9.33.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	4E-06	4E-06
			Barium	NA	NA	NA	NA	Urinary	NA	NA	6E-05	6E-05
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-05	2E-05
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	1E-05	1E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	5E-06	5E-06
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	1E-03	1E-03
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	5E-06	5E-06
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	4E-05	4E-05
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	1E-06	1E-06
		Exposure Point Total		NA	NA	NA	NA		NA	NA	2E-03	2E-03
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	6E-05	1E-02
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	9E-04	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-03	NA	2E-04	2E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	2E-04	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	8E-05	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	2E-02	2E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	8E-05	3E-03
			Vanadium	NA	NA	NA	NA	Dermal	2E-03	NA	5E-04	3E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	5E-03	NA	2E-05	5E-03
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	2E-02	3E-01
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		2E-01	NA	3E-02	3E-01
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		2E-01	NA	2E-02	3E-01
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		2E-01	NA	3E-02	3E-01
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		2E-01	NA	2E-02	3E-01

TABLE 9.33.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-01	NA	NA	5E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	NA	9E-02
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-02	NA	NA	3E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	4E-01	NA	NA	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	NA	3E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	NA	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	NA	1E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		2E+00	NA	3E-02	2E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		2E+00	NA	3E-02	2E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	Sw (swimming)	Biota
Total Cardiovascular HI Across Media =	0.001	NA	0.09
Total Dermal HI Across Media =	0.002	0.003	0.3
Total Developmental HI Across Media =	NA	NA	0.4
Total Endocrine HI Across Media =	0.003	NA	0.2
Total Gastrointestinal HI Across Media =	0.002	0.05	0.02
Total Hematologic HI Across Media =	0.002	0.005	0.7
Total Immune HI Across Media =	0.001	0.005	0.03
Total Nervous HI Across Media =	0.01	0.2	0.6
Total Not specified HI Across Media =	0.000002	NA	0.0002
Total Urinary HI Across Media =	0.002	0.01	0.03
Total Whole Body HI Across Media =	0.0009	0.003	0.5

	Total
Total Cardiovascular HI Across Media =	0.09
Total Dermal HI Across Media =	0.3
Total Developmental HI Across Media =	0.4
Total Endocrine HI Across Media =	0.2
Total Gastrointestinal HI Across Media =	0.07
Total Hematologic HI Across Media =	0.7
Total Immune HI Across Media =	0.03
Total Nervous HI Across Media =	0.8
Total Not specified HI Across Media =	0.0002
Total Urinary HI Across Media =	0.05
Total Whole Body HI Across Media =	0.5

TABLE 9.34.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	9E-03	NA	NA	9E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-03	NA	1E-03	1E-02
			Barium	NA	NA	NA	NA	Urinary	7E-04	NA	NA	7E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-04	NA	NA	4E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-02	NA	1E-03	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-05	NA	NA	2E-05
			Cobalt	NA	NA	NA	NA	Endocrine	3E-02	NA	NA	3E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-04	NA	NA	3E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	5E-03	NA	NA	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	8E-04	NA	NA	8E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	8E-04	NA	NA	8E-04
			Silver	NA	NA	NA	NA	Dermal	2E-04	NA	NA	2E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-03	NA	NA	6E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-03	NA	NA	7E-03
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	3E-03	2E-01
	Exposure Medium Total			NA	NA	NA	NA		2E-01	NA	3E-03	2E-01
Medium Total				NA	NA	NA	NA		2E-01	NA	3E-03	2E-01
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	2E-04	NA	1E-05	2E-04
			Barium	NA	NA	NA	NA	Urinary	2E-04	NA	2E-04	4E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-05	NA	5E-05	9E-05
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-04	NA	4E-05	8E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-04	NA	1E-05	3E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-03	NA	4E-03	7E-03
			Nickel	NA	NA	NA	NA	Whole Body	6E-05	NA	1E-05	7E-05
			Vanadium	NA	NA	NA	NA	Dermal	5E-05	NA	1E-04	1E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E-05	NA	3E-06	1E-04
		Exposure Point Total		NA	NA	NA	NA		5E-03	NA	5E-03	9E-03

TABLE 9.34.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	9E-06	9E-06
			Barium	NA	NA	NA	NA	Urinary	NA	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	4E-05	4E-05
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	3E-05	3E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	1E-05	1E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	3E-03	3E-03
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	1E-05	1E-05
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	7E-05	7E-05
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	2E-06	2E-06
		Exposure Point Total		NA	NA	NA	NA		NA	NA	3E-03	3E-03
		Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	8E-05	2E-02
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E-03	NA	3E-04	4E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	6E-02	NA	3E-04	6E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	1E-04	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	3E-02	3E-01
			Nickel	NA	NA	NA	NA	Whole Body	4E-03	NA	1E-04	5E-03
			Vanadium	NA	NA	NA	NA	Dermal	4E-03	NA	7E-04	5E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-03	NA	2E-05	8E-03
		Exposure Point Total		NA	NA	NA	NA		4E-01	NA	3E-02	4E-01
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		4E-01	NA	3E-02	4E-01
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		4E-01	NA	3E-02	4E-01
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		4E-01	NA	3E-02	4E-01
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		4E-01	NA	3E-02	4E-01

TABLE 9.34.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E+00	NA	NA	1E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	NA	2E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-02	NA	NA	8E-02
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
Medium Total				NA	NA	NA	NA		4E+00	NA	NA	4E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		5E+00	NA	4E-02	5E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		5E+00	NA	4E-02	5E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	Sw (swimming)	Biota
Total Cardiovascular HI Across Media =	0.01	NA	0.2
Total Dermal HI Across Media =	0.02	0.005	0.7
Total Developmental HI Across Media =	NA	NA	1
Total Endocrine HI Across Media =	0.03	NA	0.5
Total Gastrointestinal HI Across Media =	0.03	0.09	0.05
Total Hematologic HI Across Media =	0.02	0.008	**2**
Total Immune HI Across Media =	0.01	0.008	0.08
Total Nervous HI Across Media =	0.1	0.3	**2**
Total Not specified HI Across Media =	0.00002	NA	0.0005
Total Urinary HI Across Media =	0.02	0.02	0.09
Total Whole Body HI Across Media =	0.01	0.005	1

	Total
Total Cardiovascular HI Across Media =	0.3
Total Dermal HI Across Media =	0.7
Total Developmental HI Across Media =	1
Total Endocrine HI Across Media =	0.6
Total Gastrointestinal HI Across Media =	0.2
Total Hematologic HI Across Media =	**2**
Total Immune HI Across Media =	0.1
Total Nervous HI Across Media =	**2**
Total Not specified HI Across Media =	0.0005
Total Urinary HI Across Media =	0.1
Total Whole Body HI Across Media =	1

TABLE 9.35.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-07	NA	7E-08	5E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-07	NA	7E-08	5E-07		NA	NA	NA	NA
	Exposure Medium Total			5E-07	NA	7E-08	5E-07		NA	NA	NA	NA
Medium Total				5E-07	NA	7E-08	5E-07		NA	NA	NA	NA

TABLE 9.35.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	NA	NA
		Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	NA	NA

TABLE 9.35.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	NA	NA
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		NA	NA	NA	NA
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		NA	NA	NA	NA
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		NA	NA	NA	NA
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		NA	NA	NA	NA

TABLE 9.35.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lost Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	NA	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-05	NA	NA	2E-05		NA	NA	NA	NA
	Exposure Medium Total			2E-05	NA	NA	2E-05		NA	NA	NA	NA
Medium Total				2E-05	NA	NA	2E-05		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)				2E-05	NA	7E-08	2E-05		NA	NA	NA	NA
Receptor Total (Sediment + Wading + Potable Use + Fish)				2E-05	NA	7E-08	2E-05		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	4E-02	NA	NA	4E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-02	NA	NA	2E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	4E-02	2E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	NA	1E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Boron	NA	NA	NA	NA	Developmental	3E-04	NA	NA	3E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	4E-02	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	4E-01	NA	NA	4E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-01	NA	NA	3E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	1E-01	NA	NA	1E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	3E-03	NA	NA	3E-03
			Molybdenum	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	9E-03	NA	NA	9E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-03	NA	NA	6E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	8E-03	NA	NA	8E-03
			Strontium	NA	NA	NA	NA	Musculoskeletal	9E-04	NA	NA	9E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	8E-02	NA	NA	8E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-02	NA	NA	6E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	8E-02	2E+00
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	8E-02	2E+00
Medium Total				NA	NA	NA	NA		2E+00	NA	8E-02	2E+00

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	3E-03	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-02	NA	2E-02	4E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-02	NA	4E-03	3E-02
			Barium	NA	NA	NA	NA	Urinary	3E-03	NA	8E-03	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	1E-01	1E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	5E-03	NA	9E-02	9E-02
			Cobalt	NA	NA	NA	NA	Endocrine	5E-02	NA	4E-03	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	2E-04	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	4E-03	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-02	NA	3E-01	4E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-02	NA	4E-02	5E-02
			Molybdenum	NA	NA	NA	NA	Urinary	5E-03	NA	1E-03	6E-03
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	3E-03	7E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-04	NA	1E-04	8E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-03	NA	2E-02	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-03	NA	7E-04	6E-03
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	6E-01	8E-01

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	7E-02	NA	4E-04	7E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-02	NA	3E-03	8E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	6E-04	1E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-02	1E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	3E-02	NA	1E-02	4E-02
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	5E-04	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	6E-03	NA	3E-05	6E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	5E-04	9E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	4E-02	4E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	6E-02	NA	5E-03	7E-02
			Molybdenum	NA	NA	NA	NA	Urinary	3E-02	NA	2E-04	3E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	5E-04	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	2E-05	3E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	3E-03	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	1E-04	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	8E-02	1E+00

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	3E-02	NA	5E-04	3E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	3E-02	NA	4E-03	4E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E-02	NA	9E-04	4E-02
			Barium	NA	NA	NA	NA	Urinary	6E-03	NA	2E-03	7E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-02	NA	2E-02	7E-02
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	1E-02	NA	2E-02	3E-02
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	8E-04	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	4E-05	2E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	7E-04	4E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E-01	NA	6E-02	2E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-02	NA	7E-03	3E-02
			Molybdenum	NA	NA	NA	NA	Urinary	1E-02	NA	2E-04	1E-02
			Nickel	NA	NA	NA	NA	Whole Body	7E-03	NA	7E-04	7E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-03	NA	3E-05	1E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-03	NA	5E-03	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	1E-04	1E-02
		Exposure Point Total		NA	NA	NA	NA		5E-01	NA	1E-01	6E-01

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	3E+00	NA	3E+00
			Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	4E-01	NA	4E-01
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+00	NA	1E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	2E+00	NA	2E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	2E+00	NA	2E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	3E+01	NA	3E+01
			Mercury (HgCl)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Respiratory	NA	7E-01	NA	7E-01
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	2E-04	NA	2E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	NA	2E-01	NA	2E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	4E+01	NA	4E+01
	Exposure Medium Total			NA	NA	NA	NA		2E+00	4E+01	8E-01	4E+01
Medium Total				NA	NA	NA	NA		2E+00	4E+01	8E-01	4E+01

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-03	NA	NA	7E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	NA	7E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	8E-02	NA	NA	8E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	5E-02	NA	NA	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	NA	6E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	NA	8E-01
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	5E-02	NA	NA	5E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	7E-01	NA	NA	7E-01
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		7E+00	NA	NA	7E+00
		Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E-02	NA	NA	6E-02
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	3E-03	NA	NA	3E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	1E-04	NA	NA	1E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-02	NA	NA	6E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-02	NA	NA	6E-02
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	5E-03	NA	NA	5E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-01	NA	NA	8E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-03	NA	NA	2E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	6E-01	NA	NA	6E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	NA	1E+01
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	7E-01	NA	NA	7E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E+00	NA	NA	1E+00
			Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	3E-03	NA	NA	3E-03
			Cobalt	NA	NA	NA	NA	Endocrine	2E+01	NA	NA	2E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+01	NA	NA	2E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	4E+00	NA	NA	4E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Vanadium	NA	NA	NA	NA	Dermal	9E-01	NA	NA	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01

TABLE 9.36.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-04	7E-04
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	7E-03	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	7E-03	1E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		1E+02	4E+01	9E-01	1E+02

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.2	0.6	**2**
Total Dermal HI Across Media =	0.3	0.7	**4**
Total Developmental HI Across Media =	0.0003	**2**	**2**
Total Endocrine HI Across Media =	0.4	0.4	**24**
Total Gastrointestinal HI Across Media =	0.4	0.2	**18**
Total Hematologic HI Across Media =	0.09	0.2	**15**
Total Hepatic HI Across Media =	NA	0.0002	NA
Total Immune HI Across Media =	0.06	0.2	**10**
Total Musculoskeletal HI Across Media =	0.0009	NA	NA
Total Nervous HI Across Media =	0.3	**33**	**12**
Total Not specified HI Across Media =	0.1	0.2	0.004
Total Reproductive HI Across Media =	NA	0.4	NA
Total Respiratory HI Across Media =	NA	**6**	NA
Total Urinary HI Across Media =	0.3	**2**	**29**
Total Whole Body HI Across Media =	0.03	0.2	**4**

	Total
Total Cardiovascular HI Across Media =	**3**
Total Dermal HI Across Media =	**5**
Total Developmental HI Across Media =	**4**
Total Endocrine HI Across Media =	**25**
Total Gastrointestinal HI Across Media =	**18**
Total Hematologic HI Across Media =	**15**
Total Hepatic HI Across Media =	0.0002
Total Immune HI Across Media =	**10**
Total Musculoskeletal HI Across Media =	0.0009
Total Nervous HI Across Media =	**45**
Total Not specified HI Across Media =	0.3
Total Reproductive HI Across Media =	0.4
Total Respiratory HI Across Media =	**6**
Total Urinary HI Across Media =	**31**
Total Whole Body HI Across Media =	**4**

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E-01	NA	NA	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	7E-01	NA	6E-02	8E-01
			Barium	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Boron	NA	NA	NA	NA	Developmental	1E-03	NA	NA	1E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	9E-01	NA	6E-02	1E+00
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E+00	NA	NA	2E+00
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	6E-01	NA	NA	6E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E+00	NA	NA	1E+00
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-02	NA	NA	1E-02
			Molybdenum	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-02	NA	NA	3E-02
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	4E-02	NA	NA	4E-02
			Strontium	NA	NA	NA	NA	Musculoskeletal	4E-03	NA	NA	4E-03
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	4E-01	NA	NA	4E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		8E+00	NA	1E-01	9E+00
	Exposure Medium Total			NA	NA	NA	NA		8E+00	NA	1E-01	9E+00
Medium Total				NA	NA	NA	NA		8E+00	NA	1E-01	9E+00

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	3E-03	6E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	7E-02	NA	2E-02	9E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	5E-03	1E-01
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	9E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-01	2E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-02	NA	1E-01	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	4E-03	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	3E-04	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	4E-03	8E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	4E-01	6E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	5E-02	NA	4E-02	9E-02
			Molybdenum	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	3E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	4E-03	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	2E-04	3E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	3E-02	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	8E-04	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	7E-01	2E+00

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	4E-04	1E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E-01	NA	3E-03	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	7E-04	2E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	2E-02	2E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	4E-02	NA	1E-02	5E-02
			Cobalt	NA	NA	NA	NA	Endocrine	3E-01	NA	6E-04	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	4E-05	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	6E-04	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	5E-02	5E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	9E-02	NA	6E-03	1E-01
			Molybdenum	NA	NA	NA	NA	Urinary	4E-02	NA	2E-04	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	5E-04	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	2E-05	5E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	4E-03	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-02	NA	1E-04	4E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	1E-01	2E+00

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	8E-04	1E-01
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	6E-03	2E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	1E-03	2E-01
			Barium	NA	NA	NA	NA	Urinary	3E-02	NA	2E-03	3E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	3E-02	3E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	5E-02	NA	3E-02	8E-02
			Cobalt	NA	NA	NA	NA	Endocrine	4E-01	NA	1E-03	4E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	7E-05	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	1E-03	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6E-01	NA	9E-02	7E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-01	NA	1E-02	1E-01
			Molybdenum	NA	NA	NA	NA	Urinary	5E-02	NA	3E-04	5E-02
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	1E-03	3E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-03	NA	4E-05	6E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-02	NA	7E-03	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-02	NA	2E-04	6E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	2E-01	2E+00

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	Nervous	NA	3E+00	NA	3E+00
			Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	NA	4E-01	NA	4E-01
			Barium	NA	NA	NA	NA	Developmental	NA	1E+00	NA	1E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+00	NA	1E+00
			Chromium (hexavalent)	NA	NA	NA	NA	Respiratory	NA	2E+00	NA	2E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	2E+00	NA	2E+00
			Copper	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	3E+01	NA	3E+01
			Mercury (HgCl)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Respiratory	NA	7E-01	NA	7E-01
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	NA	2E-04	NA	2E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	NA	2E-01	NA	2E-01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	4E+01	NA	4E+01
	Exposure Medium Total			NA	NA	NA	NA		5E+00	4E+01	1E+00	5E+01
Medium Total				NA	NA	NA	NA		5E+00	4E+01	1E+00	5E+01

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	9E-04	NA	NA	9E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-01	NA	NA	5E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-01	NA	NA	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-04	NA	NA	4E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-01	NA	NA	2E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	9E+00	NA	NA	9E+00
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	2E+00	NA	NA	2E+00
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	NA	2E+01

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1E-01	NA	NA	1E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Beryllium	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	9E-03	NA	NA	9E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	2E-02	NA	NA	2E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E-01	NA	NA	1E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E+00	NA	NA	2E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-01	NA	NA	3E-01
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-02	NA	NA	5E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	NA	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	6E-03	NA	NA	6E-03
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	NA	5E+00
	Exposure Medium Total			NA	NA	NA	NA		3E+01	NA	NA	3E+01

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	2E+00	NA	NA	2E+00
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E+00	NA	NA	4E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	NA	2E+00
			Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Beryllium	NA	NA	NA	NA	Gastrointestinal	9E-02	NA	NA	9E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	8E-03	NA	NA	8E-03
			Cobalt	NA	NA	NA	NA	Endocrine	5E+01	NA	NA	5E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+01	NA	NA	4E+01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E+01	NA	NA	1E+01
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Vanadium	NA	NA	NA	NA	Dermal	2E+00	NA	NA	2E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		2E+02	NA	NA	2E+02
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	NA	NA
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1E-03	1E-03
			Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Medium Total				NA	NA	NA	NA		2E+02	NA	1E-02	2E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		2E+02	4E+01	1E+00	3E+02

TABLE 9.37.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	0.8	0.9	**5**
Total Dermal HI Across Media =	1	1	**10**
Total Developmental HI Across Media =	0.001	**2**	**5**
Total Endocrine HI Across Media =	**2**	1	**56**
Total Gastrointestinal HI Across Media =	**2**	0.4	**42**
Total Hematologic HI Across Media =	0.4	0.5	**34**
Total Hepatic HI Across Media =	NA	0.0002	NA
Total Immune HI Across Media =	0.3	0.4	**24**
Total Musculoskeletal HI Across Media =	0.004	NA	NA
Total Nervous HI Across Media =	1	**34**	**28**
Total Not specified HI Across Media =	0.6	0.3	0.01
Total Reproductive HI Across Media =	NA	0.4	NA
Total Respiratory HI Across Media =	NA	**6**	NA
Total Urinary HI Across Media =	1	**2**	**68**
Total Whole Body HI Across Media =	0.2	0.4	**8**

	Total
Total Cardiovascular HI Across Media =	**7**
Total Dermal HI Across Media =	**13**
Total Developmental HI Across Media =	**6**
Total Endocrine HI Across Media =	**59**
Total Gastrointestinal HI Across Media =	**44**
Total Hematologic HI Across Media =	**35**
Total Hepatic HI Across Media =	0.0002
Total Immune HI Across Media =	**24**
Total Musculoskeletal HI Across Media =	0.004
Total Nervous HI Across Media =	**63**
Total Not specified HI Across Media =	0.9
Total Reproductive HI Across Media =	0.4
Total Respiratory HI Across Media =	**6**
Total Urinary HI Across Media =	**72**
Total Whole Body HI Across Media =	**9**

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	9E-05	NA	2E-05	1E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Boron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Phosphorus	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Strontium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		9E-05	NA	2E-05	1E-04		NA	NA	NA	NA
	Exposure Medium Total			9E-05	NA	2E-05	1E-04		NA	NA	NA	NA
Medium Total				9E-05	NA	2E-05	1E-04		NA	NA	NA	NA

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	1E-05	NA	2E-06	1E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	2E-05	NA	1E-04	2E-04	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	1E-04	2E-04		NA	NA	NA	NA

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-05	NA	3E-07	5E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	5E-05	NA	2E-05	7E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		1E-04	NA	2E-05	1E-04		NA	NA	NA	NA

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	4E-07	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	2E-05	NA	2E-05	4E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-05	NA	2E-05	7E-05		NA	NA	NA	NA

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	3E-05	NA	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	2E-05	NA	2E-05	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	1E-03	NA	1E-03	---	NA	NA	NA	NA
			Cobalt	NA	1E-04	NA	1E-04	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	2E-05	NA	2E-05	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	1E-03	NA	1E-03		NA	NA	NA	NA
	Exposure Medium Total			2E-04	1E-03	2E-04	2E-03		NA	NA	NA	NA
Medium Total				2E-04	1E-03	2E-04	2E-03		NA	NA	NA	NA

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	7E-05	NA	NA	7E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-05	NA	NA	7E-05		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	4E-04	NA	NA	4E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	NA	4E-04		NA	NA	NA	NA

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	3E-05	NA	NA	3E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		3E-05	NA	NA	3E-05		NA	NA	NA	NA
		Semi-Aquatic Mammals Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	6E-05	NA	NA	6E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	NA	6E-05		NA	NA	NA	NA
	Exposure Medium Total			6E-04	NA	NA	6E-04		NA	NA	NA	NA

TABLE 9.38.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	5E-04	NA	NA	5E-04	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-04	NA	NA	5E-04		NA	NA	NA	NA
		Aquatic Plant (as Salve) Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-07	3E-07		NA	NA	NA	NA
	Exposure Medium Total			5E-04	NA	3E-07	5E-04		NA	NA	NA	NA
Medium Total				1E-03	NA	3E-07	1E-03		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				1E-03	1E-03	2E-04	3E-03		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 9.39.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-02	NA	NA	2E-02
			Arsenic	2E-05	NA	2E-05	4E-05	Cardiovascular, Dermal	1E-01	NA	3E-02	2E-01
			Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Boron	NA	NA	NA	NA	Developmental	2E-04	NA	NA	2E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	3E-02	2E-01
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	3E-01	NA	NA	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	NA	2E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-01	NA	NA	3E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	1E-01	NA	NA	1E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E-01	NA	NA	2E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-03	NA	NA	2E-03
			Molybdenum	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	7E-03	NA	NA	7E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	NA	5E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	6E-03	NA	NA	6E-03
			Strontium	NA	NA	NA	NA	Musculoskeletal	7E-04	NA	NA	7E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	5E-02	NA	NA	5E-02
		Exposure Point Total		2E-05	NA	2E-05	4E-05		1E+00	NA	6E-02	2E+00
	Exposure Medium Total			2E-05	NA	2E-05	4E-05		1E+00	NA	6E-02	2E+00
Medium Total				2E-05	NA	2E-05	4E-05		1E+00	NA	6E-02	2E+00

TABLE 9.39.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Aluminum	NA	NA	NA	NA	Nervous	1E-02	NA	2E-03	1E-02
			Antimony	NA	NA	NA	NA	NA	1E-02	NA	2E-02	3E-02
			Arsenic	3E-06	NA	6E-07	3E-06	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	2E-02	NA	4E-03	2E-02
			Barium	NA	NA	NA	NA	Developmental	2E-03	NA	6E-03	9E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	8E-02	1E-01
			Chromium (hexavalent)	2E-06	NA	4E-05	4E-05	Respiratory	4E-03	NA	7E-02	8E-02
			Cobalt	NA	NA	NA	NA	Respiratory	4E-02	NA	3E-03	4E-02
			Copper	NA	NA	NA	NA	NA	9E-04	NA	2E-04	1E-03
			Iron	NA	NA	NA	NA	NA	1E-02	NA	3E-03	2E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-02	NA	3E-01	3E-01
			Mercury (HgCl)	NA	NA	NA	NA	NA	9E-03	NA	3E-02	4E-02
			Molybdenum	NA	NA	NA	NA	NA	4E-03	NA	9E-04	5E-03
			Nickel	NA	NA	NA	NA	Respiratory	3E-03	NA	3E-03	5E-03
			Selenium	NA	NA	NA	NA	Hepatic, Cardiovascular, Nervous	5E-04	NA	1E-04	6E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Respiratory	2E-03	NA	2E-02	2E-02
			Zinc	NA	NA	NA	NA	NA	5E-03	NA	6E-04	5E-03
		Exposure Point Total		5E-06	NA	4E-05	4E-05		2E-01	NA	5E-01	7E-01
	Exposure Medium Total			5E-06	NA	4E-05	4E-05		2E-01	NA	5E-01	7E-01
Medium Total				5E-06	NA	4E-05	4E-05		2E-01	NA	5E-01	7E-01
Receptor Total (Sediment + Surface Water)				3E-05	NA	6E-05	8E-05		2E+00	NA	6E-01	2E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW
Total Cardiovascular HI Across Media =	0.2	0.02
Total Dermal HI Across Media =	0.2	0.02
Total Developmental HI Across Media =	0.0002	0.03
Total Endocrine HI Across Media =	0.3	NA
Total Gastrointestinal HI Across Media =	0.3	NA
Total Hematologic HI Across Media =	0.07	NA
Total Hepatic HI Across Media =	NA	0.0006
Total Immune HI Across Media =	0.05	NA
Total Musculoskeletal HI Across Media =	0.0007	NA
Total Nervous HI Across Media =	0.2	0.3
Total Not specified HI Across Media =	0.1	NA
Total Reproductive HI Across Media =	NA	0.02
Total Respiratory HI Across Media =	NA	0.2
Total Urinary HI Across Media =	0.3	0.1
Total Whole Body HI Across Media =	0.03	NA

	Total
Total Cardiovascular HI Across Media =	0.2
Total Dermal HI Across Media =	0.3
Total Developmental HI Across Media =	0.03
Total Endocrine HI Across Media =	0.3
Total Gastrointestinal HI Across Media =	0.3
Total Hematologic HI Across Media =	0.07
Total Hepatic HI Across Media =	0.0006
Total Immune HI Across Media =	0.05
Total Musculoskeletal HI Across Media =	0.0007
Total Nervous HI Across Media =	0.5
Total Not specified HI Across Media =	0.1
Total Reproductive HI Across Media =	0.02
Total Respiratory HI Across Media =	0.2
Total Urinary HI Across Media =	0.4
Total Whole Body HI Across Media =	0.03

TABLE 9.40.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	8E-04	NA	NA	8E-04
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-04	NA	NA	5E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-03	NA	7E-04	4E-03
			Barium	NA	NA	NA	NA	Urinary	2E-04	NA	NA	2E-04
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-04	NA	NA	1E-04
			Boron	NA	NA	NA	NA	Developmental	6E-06	NA	NA	6E-06
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	4E-03	NA	6E-04	4E-03
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-06	NA	NA	4E-06
			Cobalt	NA	NA	NA	NA	Endocrine	8E-03	NA	NA	8E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	6E-05	NA	NA	6E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-03	NA	NA	7E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	3E-03	NA	NA	3E-03
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-03	NA	NA	4E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	5E-05	NA	NA	5E-05
			Molybdenum	NA	NA	NA	NA	Urinary	2E-03	NA	NA	2E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-04	NA	NA	2E-04
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-04	NA	NA	1E-04
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-04	NA	NA	2E-04
			Strontium	NA	NA	NA	NA	Musculoskeletal	2E-05	NA	NA	2E-05
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-03	NA	NA	2E-03
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-03	NA	NA	1E-03
		Exposure Point Total		NA	NA	NA	NA		4E-02	NA	1E-03	4E-02
	Exposure Medium Total			NA	NA	NA	NA		4E-02	NA	1E-03	4E-02
Medium Total				NA	NA	NA	NA		4E-02	NA	1E-03	4E-02

TABLE 9.40.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	2E-04	NA	4E-05	2E-04
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-04	NA	3E-04	5E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-04	NA	6E-05	3E-04
			Barium	NA	NA	NA	NA	Urinary	3E-05	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	3E-04	NA	1E-03	2E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	7E-05	NA	1E-03	1E-03
			Cobalt	NA	NA	NA	NA	Endocrine	6E-04	NA	5E-05	6E-04
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-05	NA	3E-06	2E-05
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-04	NA	5E-05	3E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	8E-04	NA	4E-03	5E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	2E-04	NA	5E-04	6E-04
			Molybdenum	NA	NA	NA	NA	Urinary	7E-05	NA	1E-05	8E-05
			Nickel	NA	NA	NA	NA	Whole Body	4E-05	NA	4E-05	9E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	8E-06	NA	2E-06	1E-05
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	4E-05	NA	3E-04	4E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-05	NA	9E-06	8E-05
		Exposure Point Total		NA	NA	NA	NA		3E-03	NA	8E-03	1E-02

TABLE 9.40.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	2E-05	2E-05
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	2E-04	2E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	4E-05	4E-05
			Barium	NA	NA	NA	NA	Urinary	NA	NA	7E-05	7E-05
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	8E-04	8E-04
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	7E-04	7E-04
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	3E-05	3E-05
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	2E-06	2E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	3E-05	3E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	3E-03	3E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	NA	NA	3E-04	3E-04
			Molybdenum	NA	NA	NA	NA	Urinary	NA	NA	9E-06	9E-06
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	3E-05	3E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	1E-06	1E-06
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	2E-04	2E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	6E-06	6E-06
		Exposure Point Total		NA	NA	NA	NA		NA	NA	5E-03	5E-03

TABLE 9.40.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	6E-02	NA	3E-04	6E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	7E-02	NA	3E-03	7E-02
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	5E-04	9E-02
			Barium	NA	NA	NA	NA	Urinary	1E-02	NA	9E-04	1E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-02	1E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	2E-02	NA	1E-02	3E-02
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	4E-04	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	3E-05	5E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	4E-04	8E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E-01	NA	4E-02	3E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	5E-02	NA	4E-03	6E-02
			Molybdenum	NA	NA	NA	NA	Urinary	2E-02	NA	1E-04	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	4E-04	1E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	3E-03	NA	2E-05	3E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	1E-02	NA	3E-03	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	8E-05	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	7E-02	1E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		1E+00	NA	8E-02	1E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		1E+00	NA	8E-02	1E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		1E+00	NA	8E-02	1E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		1E+00	NA	8E-02	1E+00

TABLE 9.40.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	NA	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-01	NA	NA	5E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	9E-02	NA	NA	9E-02
			Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-02	NA	NA	3E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	2E-04	NA	NA	2E-04
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-03	NA	NA	4E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	1E-02	NA	NA	1E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	4E-01	NA	NA	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-03	NA	NA	3E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-01	NA	NA	1E-01
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	NA	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	NA	1E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		3E+00	NA	8E-02	3E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		3E+00	NA	8E-02	3E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.004	0.09	0.09
Total Dermal HI Across Media =	0	0.1	0.3
Total Developmental HI Across Media =	0.000006	NA	0.4
Total Endocrine HI Across Media =	0.008	0.2	0.2
Total Gastrointestinal HI Across Media =	0.007	0.08	0.02
Total Hematologic HI Across Media =	0.002	0.1	0.7
Total Immune HI Across Media =	0.001	0.08	0.03
Total Musculoskeletal HI Across Media =	0.00002	NA	NA
Total Nervous HI Across Media =	0.005	0.4	0.6
Total Not specified HI Across Media =	0.003	0.03	0.0002
Total Reproductive HI Across Media =	NA	NA	NA
Total Urinary HI Across Media =	0.007	0.2	0.03
Total Whole Body HI Across Media =	0.0006	0.09	0.5

	Total
Total Cardiovascular HI Across Media =	0.2
Total Dermal HI Across Media =	0
Total Developmental HI Across Media =	0.4
Total Endocrine HI Across Media =	0.4
Total Gastrointestinal HI Across Media =	0.1
Total Hematologic HI Across Media =	0.8
Total Immune HI Across Media =	0.1
Total Musculoskeletal HI Across Media =	0.00002
Total Nervous HI Across Media =	0.9
Total Not specified HI Across Media =	0.04
Total Reproductive HI Across Media =	NA
Total Urinary HI Across Media =	0.2
Total Whole Body HI Across Media =	0.6

TABLE 9.41.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	Nervous	8E-03	NA	NA	8E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	5E-03	NA	NA	5E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E-02	NA	4E-03	4E-02
			Barium	NA	NA	NA	NA	Urinary	2E-03	NA	NA	2E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-03	NA	NA	1E-03
			Boron	NA	NA	NA	NA	Developmental	6E-05	NA	NA	6E-05
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	4E-02	NA	4E-03	4E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	4E-05	NA	NA	4E-05
			Cobalt	NA	NA	NA	NA	Endocrine	9E-02	NA	NA	9E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	6E-04	NA	NA	6E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-02	NA	NA	7E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	Not specified	3E-02	NA	NA	3E-02
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-02	NA	NA	5E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	6E-04	NA	NA	6E-04
			Molybdenum	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Phosphorus	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	1E-03	NA	NA	1E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	Dermal	2E-03	NA	NA	2E-03
			Strontium	NA	NA	NA	NA	Musculoskeletal	2E-04	NA	NA	2E-04
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	NA	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-02	NA	NA	1E-02
		Exposure Point Total		NA	NA	NA	NA		4E-01	NA	8E-03	4E-01
	Exposure Medium Total			NA	NA	NA	NA		4E-01	NA	8E-03	4E-01
Medium Total				NA	NA	NA	NA		4E-01	NA	8E-03	4E-01

TABLE 9.41.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	Nervous	1E-03	NA	6E-05	1E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E-03	NA	5E-04	2E-03
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-03	NA	1E-04	2E-03
			Barium	NA	NA	NA	NA	Urinary	2E-04	NA	2E-04	4E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-03	NA	2E-03	4E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	5E-04	NA	2E-03	2E-03
			Cobalt	NA	NA	NA	NA	Endocrine	4E-03	NA	9E-05	4E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-04	NA	5E-06	1E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	2E-03	NA	8E-05	2E-03
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-03	NA	7E-03	1E-02
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	1E-03	NA	8E-04	2E-03
			Molybdenum	NA	NA	NA	NA	Urinary	5E-04	NA	3E-05	5E-04
			Nickel	NA	NA	NA	NA	Whole Body	3E-04	NA	8E-05	4E-04
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	6E-05	NA	3E-06	6E-05
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	3E-04	NA	5E-04	8E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	5E-04	NA	2E-05	5E-04
		Exposure Point Total		NA	NA	NA	NA		2E-02	NA	1E-02	3E-02

TABLE 9.41.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	Nervous	NA	NA	5E-05	5E-05
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	NA	NA	4E-04	4E-04
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	7E-05	7E-05
			Barium	NA	NA	NA	NA	Urinary	NA	NA	1E-04	1E-04
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-03	2E-03
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	NA	NA	1E-03	1E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	7E-05	7E-05
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	4E-06	4E-06
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	6E-05	6E-05
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	5E-03	5E-03
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	NA	NA	6E-04	6E-04
			Molybdenum	NA	NA	NA	NA	Urinary	NA	NA	2E-05	2E-05
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	6E-05	6E-05
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	NA	NA	2E-06	2E-06
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	NA	NA	4E-04	4E-04
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	1E-05	1E-05
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02

TABLE 9.41.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	Nervous	9E-02	NA	4E-04	9E-02
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E-01	NA	3E-03	1E-01
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	7E-04	2E-01
			Barium	NA	NA	NA	NA	Urinary	2E-02	NA	1E-03	2E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	1E-02	2E-01
			Chromium (hexavalent)	NA	NA	NA	NA	Not specified	4E-02	NA	1E-02	5E-02
			Cobalt	NA	NA	NA	NA	Endocrine	3E-01	NA	6E-04	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-03	NA	3E-05	8E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	6E-04	1E-01
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-01	NA	5E-02	5E-01
			Mercury (HgCl)	NA	NA	NA	NA	Immune, Urinary	9E-02	NA	5E-03	9E-02
			Molybdenum	NA	NA	NA	NA	Urinary	4E-02	NA	2E-04	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	5E-04	2E-02
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	5E-03	NA	2E-05	5E-03
			Silica (as SIO2)	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	Dermal	2E-02	NA	4E-03	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-02	NA	1E-04	4E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	9E-02	2E+00
	Exposure Medium Total (Swimming + Potable Use)			NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
	Exposure Medium Total (Wading + Potable Use)			NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
Medium Total (Swimming + Potable Use)				NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
Medium Total (Wading + Potable Use)				NA	NA	NA	NA		2E+00	NA	1E-01	2E+00

TABLE 9.41.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	Nervous	3E-03	NA	NA	3E-03
			Antimony	NA	NA	NA	NA	Hematologic, Whole Body	1E+00	NA	NA	1E+00
			Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E-01	NA	NA	2E-01
			Barium	NA	NA	NA	NA	Urinary	4E-03	NA	NA	4E-03
			Beryllium	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Chromium (trivalent)	NA	NA	NA	NA	Not specified	5E-04	NA	NA	5E-04
			Cobalt	NA	NA	NA	NA	Endocrine	5E-01	NA	NA	5E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	Nervous	3E-02	NA	NA	3E-02
			Mercury (MeHg)	NA	NA	NA	NA	Developmental, Nervous	1E+00	NA	NA	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Selenium	NA	NA	NA	NA	Nervous, Hematologic, Dermal	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Thallium	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-02	NA	NA	8E-02
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
Medium Total				NA	NA	NA	NA		4E+00	NA	NA	4E+00
Receptor Total (Sediment + Swimming + Potable Use + Fish)				NA	NA	NA	NA		6E+00	NA	1E-01	6E+00
Receptor Total (Sediment + Wading + Potable Use + Fish)				NA	NA	NA	NA		6E+00	NA	1E-01	6E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW (swimming)	Biota
Total Cardiovascular HI Across Media =	0.04	0.2	0.2
Total Dermal HI Across Media =	0	0.2	0.7
Total Developmental HI Across Media =	0.00006	NA	1
Total Endocrine HI Across Media =	0.09	0.3	0.5
Total Gastrointestinal HI Across Media =	0.07	0.1	0.05
Total Hematologic HI Across Media =	0.02	0.2	**2**
Total Immune HI Across Media =	0.01	0.1	0.08
Total Musculoskeletal HI Across Media =	0.0002	NA	NA
Total Nervous HI Across Media =	0.06	0.6	**2**
Total Not specified HI Across Media =	0.03	0.05	0.0005
Total Reproductive HI Across Media =	NA	NA	NA
Total Urinary HI Across Media =	0.07	0.3	0.09
Total Whole Body HI Across Media =	0.007	0.1	1

	Total
Total Cardiovascular HI Across Media =	0.4
Total Dermal HI Across Media =	1
Total Developmental HI Across Media =	1
Total Endocrine HI Across Media =	0.9
Total Gastrointestinal HI Across Media =	0.3
Total Hematologic HI Across Media =	**2**
Total Immune HI Across Media =	0.2
Total Musculoskeletal HI Across Media =	0.0002
Total Nervous HI Across Media =	**2**
Total Not specified HI Across Media =	0.08
Total Reproductive HI Across Media =	NA
Total Urinary HI Across Media =	0.5
Total Whole Body HI Across Media =	**2**

TABLE 9.42.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-06	NA	2E-07	2E-06	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Boron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lithium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Phosphorus	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Strontium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-06	NA	2E-07	2E-06		NA	NA	NA	NA
	Exposure Medium Total			2E-06	NA	2E-07	2E-06		NA	NA	NA	NA
Medium Total				2E-06	NA	2E-07	2E-06		NA	NA	NA	NA

TABLE 9.42.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	1E-07	NA	1E-08	1E-07	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	4E-07	NA	2E-06	3E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		5E-07	NA	2E-06	3E-06		NA	NA	NA	NA

TABLE 9.42.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) Wading	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	NA	NA	7E-09	7E-09	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	NA	NA	2E-06	2E-06	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	2E-06	2E-06		NA	NA	NA	NA

TABLE 9.42.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Potable Use)	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	9E-08	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (hexavalent)	5E-05	NA	2E-05	7E-05	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (HgCl)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Molybdenum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silica (as SIO2)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Vanadium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		6E-05	NA	2E-05	8E-05		NA	NA	NA	NA
	Exposure Medium Total (Swimming + Potable Use)			6E-05	NA	2E-05	9E-05		NA	NA	NA	NA
	Exposure Medium Total (Wading + Potable Use)			6E-05	NA	2E-05	8E-05		NA	NA	NA	NA
Medium Total (Swimming + Potable Use)				6E-05	NA	2E-05	9E-05		NA	NA	NA	NA
Medium Total (Wading + Potable Use)				6E-05	NA	2E-05	8E-05		NA	NA	NA	NA

TABLE 9.42.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Lower Spring River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Aluminum	NA	NA	NA	NA	---	NA	NA	NA	NA
			Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Arsenic	2E-05	NA	NA	2E-05	---	NA	NA	NA	NA
			Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Beryllium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Chromium (trivalent)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Mercury (MeHg)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Selenium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Thallium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-05	NA	NA	2E-05		NA	NA	NA	NA
	Exposure Medium Total			2E-05	NA	NA	2E-05		NA	NA	NA	NA
Medium Total				2E-05	NA	NA	2E-05		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Fish)				9E-05	NA	2E-05	1E-04		NA	NA	NA	NA
Receptor Total (Sediment + Wading + Potable Use + Fish)				9E-05	NA	2E-05	1E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 10.1.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	1E-01	7E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
Medium Total				NA	NA	NA	NA		2E+00	NA	1E-01	2E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-02	NA	5E-02	9E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-01	NA	2E+00	3E+00
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	7E-03	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	2E-02	2E-01
		Exposure Point Total		NA	NA	NA	NA		7E-01	NA	2E+00	3E+00
		Surface Water (Potable Use)	Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	7E-03	2E-01
			Cadmium (water)	NA	NA	NA	NA	Urinary	3E+00	NA	3E-01	3E+00
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	9E-04	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E-01	NA	3E-03	8E-01
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	3E-01	4E+00
		Surface Water (Sweat Lodge)	Antimony	NA	NA	NA	NA	Hematologic, Whole Body	8E-02	NA	1E-02	9E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E+00	NA	4E-01	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	1E-03	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	4E-03	3E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	4E-01	2E+00

TABLE 10.1.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E+01	NA	3E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	3E+01	NA	3E+01
	Exposure Medium Total			NA	NA	NA	NA		6E+00	3E+01	3E+00	4E+01
Medium Total				NA	NA	NA	NA		6E+00	3E+01	3E+00	4E+01
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00

TABLE 10.1.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		8E-02	NA	NA	8E-02
		Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		4E+01	NA	NA	4E+01

TABLE 10.1.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		4E+01	NA	7E-03	4E+01
Medium Total				NA	NA	NA	NA		4E+01	NA	7E-03	4E+01
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				NA	NA	NA	NA		5E+01	3E+01	3E+00	8E+01

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Dermal HI Across Media =	NA	NA	0.2
Total Gastrointestinal HI Across Media =	NA	NA	1
Total Hematologic HI Across Media =	**2**	**2**	**10**
Total Immune HI Across Media =	**2**	1	**10**
Total Respiratory HI Across Media =	NA	1	NA
Total Urinary HI Across Media =	0.7	**34**	**29**
Total Whole Body HI Across Media =	NA	0.4	0.2

	Total
Total Dermal HI Across Media =	0.2
Total Gastrointestinal HI Across Media =	1
Total Hematologic HI Across Media =	**14**
Total Immune HI Across Media =	**13**
Total Respiratory HI Across Media =	1
Total Urinary HI Across Media =	**64**
Total Whole Body HI Across Media =	0.6

TABLE 10.2.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+00	NA	2E-01	3E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	8E+00	NA	NA	8E+00
		Exposure Point Total		NA	NA	NA	NA		1E+01	NA	2E-01	1E+01
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	2E-01	1E+01
Medium Total				NA	NA	NA	NA		1E+01	NA	2E-01	1E+01
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Antimony	NA	NA	NA	NA	Hematologic, Whole Body	2E-01	NA	6E-02	2E-01
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E+00	5E+00
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	8E-03	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	2E-02	7E-01
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	3E+00	6E+00
		Surface Water (Potable Use)	Antimony	NA	NA	NA	NA	Hematologic, Whole Body	3E-01	NA	8E-03	3E-01
			Cadmium (water)	NA	NA	NA	NA	Urinary	4E+00	NA	4E-01	4E+00
			Nickel	NA	NA	NA	NA	Whole Body	5E-02	NA	1E-03	5E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	3E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		6E+00	NA	4E-01	6E+00
		Surface Water (Sweat Lodge)	Antimony	NA	NA	NA	NA	Hematologic, Whole Body	4E-01	NA	2E-02	4E-01
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E+00	NA	7E-01	6E+00
			Nickel	NA	NA	NA	NA	Whole Body	6E-02	NA	2E-03	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	6E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		7E+00	NA	7E-01	8E+00

TABLE 10.2.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Antimony	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	3E+01	NA	3E+01
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	3E+01	NA	3E+01
	Exposure Medium Total			NA	NA	NA	NA		2E+01	3E+01	4E+00	5E+01
Medium Total				NA	NA	NA	NA		2E+01	3E+01	4E+00	5E+01
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		7E-01	NA	NA	7E-01
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	NA	3E+00

TABLE 10.2.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	NA	2E-01
		Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01

TABLE 10.2.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	1E-02	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	1E-02	1E+02
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				NA	NA	NA	NA		1E+02	3E+01	4E+00	2E+02

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Dermal HI Across Media =	NA	NA	0.5
Total Gastrointestinal HI Across Media =	NA	NA	**2**
Total Hematologic HI Across Media =	**8**	**4**	**24**
Total Immune HI Across Media =	**8**	**3**	**24**
Total Respiratory HI Across Media =	NA	1	NA
Total Urinary HI Across Media =	**3**	**42**	**68**
Total Whole Body HI Across Media =	NA	1	0.5

	Total
Total Dermal HI Across Media =	0.5
Total Gastrointestinal HI Across Media =	**2**
Total Hematologic HI Across Media =	**36**
Total Immune HI Across Media =	**35**
Total Respiratory HI Across Media =	1
Total Urinary HI Across Media =	**113**
Total Whole Body HI Across Media =	**2**

TABLE 10.3.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Surface Water (Potable Use)	Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Surface Water (Sweat Lodge)	Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA

TABLE 10.3.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Antimony	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (water)	NA	5E-04	NA	5E-04	---	NA	NA	NA	NA
			Nickel	NA	3E-05	NA	3E-05	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	5E-04	NA	5E-04		NA	NA	NA	NA
	Exposure Medium Total			0E+00	5E-04	0E+00	5E-04		NA	NA	NA	NA
Medium Total				0E+00	5E-04	0E+00	5E-04		NA	NA	NA	NA
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA

TABLE 10.3.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA

TABLE 10.3.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	0E+00	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				0E+00	5E-04	0E+00	5E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 10.4.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Cadmium (water)	NA	NA	NA	NA	Urinary	4E-01	NA	2E+00	2E+00
		Exposure Point Total		0E+00	NA	NA	0E+00		4E-01	NA	2E+00	2E+00
	Exposure Medium Total			0E+00	NA	NA	0E+00		4E-01	NA	2E+00	2E+00
Medium Total				0E+00	NA	NA	0E+00		4E-01	NA	2E+00	2E+00
Receptor Total (Surface Water)				0E+00	NA	0E+00	0E+00		4E-01	NA	2E+00	2E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	SW
Total Urinary HI Across Media =	**2**

	Total
Total Urinary HI Across Media =	**2**

TABLE 10.5.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Cadmium (water)	NA	NA	NA	NA	Urinary	7E-03	NA	3E-02	4E-02
		Exposure Point Total		NA	NA	NA	NA		7E-03	NA	3E-02	4E-02
		Surface Water (Rivers & Creeks) Wading	Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-02	2E-02
		Exposure Point Total		NA	NA	NA	NA		NA	NA	2E-02	2E-02
		Surface Water (Potable Use)	Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E-01	3E+00
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	3E-01	3E+00
	Exposure Medium Total (Swimming, Potable Use)			NA	NA	NA	NA		2E+00	NA	3E-01	3E+00
	Exposure Medium Total (Wading, Potable Use)			NA	NA	NA	NA		2E+00	NA	3E-01	3E+00
Medium Total (Swimming, Potable Use)				NA	NA	NA	NA		2E+00	NA	3E-01	3E+00
Medium Total (Wading, Potable Use)				NA	NA	NA	NA		2E+00	NA	3E-01	3E+00
Receptor Total (Surface Water [Swimming, Potable Use])				NA	NA	NA	NA		2E+00	NA	3E-01	3E+00
Receptor Total (Surface Water [Wading, Potable Use])				NA	NA	NA	NA		2E+00	NA	3E-01	3E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	SW (swimming)	SW (wading)
Total Urinary HI Across Media =	**3**	**3**

	Total
Total Urinary HI Across Media =	**3**

TABLE 10.6.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Elm Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Cadmium (water)	NA	NA	NA	NA	Urinary	5E-02	NA	5E-02	1E-01
		Exposure Point Total		NA	NA	NA	NA		5E-02	NA	5E-02	1E-01
		Surface Water (Rivers & Creeks) Wading	Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	4E-02	4E-02
		Exposure Point Total		NA	NA	NA	NA		NA	NA	4E-02	4E-02
		Surface Water (Potable Use)	Cadmium (water)	NA	NA	NA	NA	Urinary	4E+00	NA	3E-01	4E+00
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	3E-01	4E+00
	Exposure Medium Total (Swimming, Potable Use)			NA	NA	NA	NA		4E+00	NA	4E-01	4E+00
	Exposure Medium Total (Wading, Potable Use)			NA	NA	NA	NA		4E+00	NA	4E-01	4E+00
Medium Total (Swimming, Potable Use)				NA	NA	NA	NA		4E+00	NA	4E-01	4E+00
Medium Total (Wading, Potable Use)				NA	NA	NA	NA		4E+00	NA	4E-01	4E+00
Receptor Total (Surface Water [Swimming, Potable Use])				NA	NA	NA	NA		4E+00	NA	4E-01	4E+00
Receptor Total (Surface Water [Wading, Potable Use])				NA	NA	NA	NA		4E+00	NA	4E-01	4E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	SW (swimming)	SW (wading)
Total Urinary HI Across Media =	**4**	**4**

	Total
Total Urinary HI Across Media =	**4**

TABLE 10.7.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E-01	2E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	3E-01	2E+00
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	3E-01	2E+00
Medium Total				NA	NA	NA	NA		2E+00	NA	3E-01	2E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E-01	NA	2E-01	9E-01
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	9E-01	1E+00
			Cobalt	NA	NA	NA	NA	Endocrine	7E-01	NA	6E-02	8E-01
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-01	NA	1E-01	6E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	5E-01	NA	2E+00	3E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E-01	NA	1E-01	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	2E-02	2E-01
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	4E+00	7E+00
		Surface Water (Potable Use)	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	4E+00	NA	2E-02	4E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E+00	NA	1E-01	1E+00
			Cobalt	NA	NA	NA	NA	Endocrine	4E+00	NA	8E-03	4E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	3E+00	NA	1E-02	3E+00
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E+00	NA	3E-01	3E+00
			Nickel	NA	NA	NA	NA	Whole Body	6E-01	NA	2E-02	6E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	3E-03	8E-01
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	5E-01	2E+01

TABLE 10.7.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	2E+00	NA	3E-02	2E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	5E-01	NA	2E-01	6E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E+00	NA	1E-02	2E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	1E+00	NA	2E-02	1E+00
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	1E+00	NA	5E-01	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	2E-02	3E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	4E-03	3E-01
		Exposure Point Total		NA	NA	NA	NA		6E+00	NA	7E-01	7E+00
		Water Vapor (Sweat Lodge)	Arsenic	NA	NA	NA	NA	Reproductive, Developmenta	NA	2E+01	NA	2E+01
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+01	NA	1E+01
			Cobalt	NA	NA	NA	NA	Respiratory	NA	4E+01	NA	4E+01
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	2E+02	NA	2E+02
			Nickel	NA	NA	NA	NA	Respiratory	NA	3E+01	NA	3E+01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	3E+02	NA	3E+02
	Exposure Medium Total			NA	NA	NA	NA		2E+01	3E+02	5E+00	3E+02
Medium Total				NA	NA	NA	NA		2E+01	3E+02	5E+00	3E+02

TABLE 10.7.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00
		Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		8E-02	NA	NA	8E-02

TABLE 10.7.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	NA	2E+00
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		4E+01	NA	NA	4E+01
		Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		4E+01	NA	7E-03	4E+01
Medium Total				NA	NA	NA	NA		4E+01	NA	7E-03	4E+01

TABLE 10.7.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				NA	NA	NA	NA		7E+01	3E+02	5E+00	4E+02

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	NA	**22**	NA
Total Dermal HI Across Media =	NA	**22**	0.2
Total Developmental HI Across Media =	NA	**16**	NA
Total Endocrine HI Across Media =	NA	**6**	NA
Total Gastrointestinal HI Across Media =	NA	**4**	1
Total Hematologic HI Across Media =	0.3	1	**10**
Total Immune HI Across Media =	0.3	1	**10**
Total Nervous HI Across Media =	NA	**246**	NA
Total Reproductive HI Across Media =	NA	**16**	NA
Total Respiratory HI Across Media =	NA	**78**	NA
Total Urinary HI Across Media =	**2**	**14**	**29**
Total Whole Body HI Across Media =	NA	1	0.2

	Total
Total Cardiovascular HI Across Media =	**22**
Total Dermal HI Across Media =	**22**
Total Developmental HI Across Media =	**16**
Total Endocrine HI Across Media =	**6**
Total Gastrointestinal HI Across Media =	**5**
Total Hematologic HI Across Media =	**12**
Total Immune HI Across Media =	**12**
Total Nervous HI Across Media =	**246**
Total Reproductive HI Across Media =	**16**
Total Respiratory HI Across Media =	**78**
Total Urinary HI Across Media =	**46**
Total Whole Body HI Across Media =	1

TABLE 10.8.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E+00	NA	5E-01	9E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		1E+01	NA	5E-01	1E+01
	Exposure Medium Total			NA	NA	NA	NA		1E+01	NA	5E-01	1E+01
Medium Total				NA	NA	NA	NA		1E+01	NA	5E-01	1E+01
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3E+00	NA	2E-01	4E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	1E+00	NA	1E+00	2E+00
			Cobalt	NA	NA	NA	NA	Endocrine	3E+00	NA	7E-02	3E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	1E-01	2E+00
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2E+00	NA	3E+00	5E+00
			Nickel	NA	NA	NA	NA	Whole Body	5E-01	NA	1E-01	7E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	6E-01	NA	2E-02	7E-01
		Exposure Point Total		NA	NA	NA	NA		1E+01	NA	4E+00	2E+01
		Surface Water (Potable Use)	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E+00	NA	3E-02	6E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	1E-01	2E+00
			Cobalt	NA	NA	NA	NA	Endocrine	5E+00	NA	1E-02	5E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+00	NA	2E-02	4E+00
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E+00	NA	4E-01	4E+00
			Nickel	NA	NA	NA	NA	Whole Body	9E-01	NA	2E-02	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	3E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	6E-01	2E+01

TABLE 10.8.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	8E+00	NA	5E-02	8E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	3E-01	2E+00
			Cobalt	NA	NA	NA	NA	Endocrine	7E+00	NA	2E-02	7E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	5E+00	NA	3E-02	5E+00
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E+00	NA	7E-01	5E+00
			Nickel	NA	NA	NA	NA	Whole Body	1E+00	NA	4E-02	1E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E+00	NA	5E-03	1E+00
		Exposure Point Total		NA	NA	NA	NA		3E+01	NA	1E+00	3E+01
		Water Vapor (Sweat Lodge)	Arsenic	NA	NA	NA	NA	Reproductive, Developmenta	NA	2E+01	NA	2E+01
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+01	NA	1E+01
			Cobalt	NA	NA	NA	NA	Respiratory	NA	4E+01	NA	4E+01
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	2E+02	NA	2E+02
			Nickel	NA	NA	NA	NA	Respiratory	NA	3E+01	NA	3E+01
			Zinc	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	3E+02	NA	3E+02
	Exposure Medium Total			NA	NA	NA	NA		6E+01	3E+02	6E+00	4E+02
Medium Total				NA	NA	NA	NA		6E+01	3E+02	6E+00	4E+02

TABLE 10.8.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		7E-01	NA	NA	7E-01
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	NA	3E+00
		Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	NA	2E-01

TABLE 10.8.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01
		Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	1E-02	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	1E-02	1E+02
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				NA	NA	NA	NA		2E+02	3E+02	7E+00	5E+02

TABLE 10.8.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Cardiovascular HI Across Media =	NA	**33**	NA
Total Dermal HI Across Media =	NA	**33**	0.5
Total Developmental HI Across Media =	NA	**16**	NA
Total Endocrine HI Across Media =	NA	**16**	NA
Total Gastrointestinal HI Across Media =	NA	**11**	**2**
Total Hematologic HI Across Media =	**2**	**3**	**24**
Total Immune HI Across Media =	**2**	**3**	**24**
Total Nervous HI Across Media =	NA	**253**	NA
Total Reproductive HI Across Media =	NA	**16**	NA
Total Respiratory HI Across Media =	NA	**78**	NA
Total Urinary HI Across Media =	**9**	**18**	**68**
Total Whole Body HI Across Media =	NA	**3**	0.5

	Total
Total Cardiovascular HI Across Media =	**33**
Total Dermal HI Across Media =	**33**
Total Developmental HI Across Media =	**16**
Total Endocrine HI Across Media =	**16**
Total Gastrointestinal HI Across Media =	**13**
Total Hematologic HI Across Media =	**28**
Total Immune HI Across Media =	**28**
Total Nervous HI Across Media =	**253**
Total Reproductive HI Across Media =	**16**
Total Respiratory HI Across Media =	**78**
Total Urinary HI Across Media =	**95**
Total Whole Body HI Across Media =	**3**

TABLE 10.9.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Arsenic	4E-04	NA	7E-05	5E-04	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-04	NA	7E-05	5E-04		NA	NA	NA	NA
		Surface Water (Potable Use)	Arsenic	2E-03	NA	1E-05	2E-03	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		2E-03	NA	1E-05	2E-03		NA	NA	NA	NA

TABLE 10.9.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Surface Water (Sweat Lodge)	Arsenic	9E-04	NA	1E-05	9E-04	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		9E-04	NA	1E-05	9E-04		NA	NA	NA	NA
		Water Vapor (Sweat Lodge)	Arsenic	NA	1E-03	NA	1E-03	---	NA	NA	NA	NA
			Cadmium (water)	NA	2E-04	NA	2E-04	---	NA	NA	NA	NA
			Cobalt	NA	2E-03	NA	2E-03	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	6E-04	NA	6E-04	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	4E-03	NA	4E-03		NA	NA	NA	NA
	Exposure Medium Total			3E-03	4E-03	1E-04	7E-03		NA	NA	NA	NA
Medium Total				3E-03	4E-03	1E-04	7E-03		NA	NA	NA	NA

TABLE 10.9.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA

TABLE 10.9.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue) (cont.)	Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	0E+00	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				3E-03	4E-03	1E-04	7E-03		NA	NA	NA	NA

TABLE 10.9.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 10.10.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Aquatic Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E+00	NA	3E-01	2E+00
		Exposure Point Total		0E+00	NA	0E+00	0E+00		1E+00	NA	3E-01	2E+00
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		1E+00	NA	3E-01	2E+00
Medium Total				0E+00	NA	0E+00	0E+00		1E+00	NA	3E-01	2E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Arsenic	1E-04	NA	2E-05	1E-04	Reproductive, Developmenta	6E-01	NA	1E-01	7E-01
			Cobalt	NA	NA	NA	NA	Respiratory	6E-01	NA	5E-02	6E-01
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-01	NA	2E+00	2E+00
			Nickel	NA	NA	NA	NA	Respiratory	9E-02	NA	1E-01	2E-01
		Exposure Point Total		1E-04	NA	2E-05	1E-04		2E+00	NA	2E+00	4E+00
	Exposure Medium Total			1E-04	NA	2E-05	1E-04		2E+00	NA	2E+00	4E+00
Medium Total				1E-04	NA	2E-05	1E-04		2E+00	NA	2E+00	4E+00
Receptor Total (Sediment, Surface Water)				1E-04	NA	2E-05	1E-04		3E+00	NA	2E+00	6E+00

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW
Total Cardiovascular HI Across Media =	NA	0.7
Total Dermal HI Across Media =	NA	0.7
Total Developmental HI Across Media =	NA	0.7
Total Nervous HI Across Media =	NA	**3**
Total Reproductive HI Across Media =	NA	0.7
Total Respiratory HI Across Media =	NA	**2**
Total Urinary HI Across Media =	**2**	NA

	Total
Total Cardiovascular HI Across Media =	0.7
Total Dermal HI Across Media =	0.7
Total Developmental HI Across Media =	0.7
Total Nervous HI Across Media =	**3**
Total Reproductive HI Across Media =	0.7
Total Respiratory HI Across Media =	**2**
Total Urinary HI Across Media =	**2**

TABLE 10.11.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	1.E-02	NA	2.E-03	1.E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	3.E-03	NA	1.E-02	2.E-02
			Cobalt	NA	NA	NA	NA	Endocrine	9.E-03	NA	8.E-04	1.E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	6.E-03	NA	1.E-03	8.E-03
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	6.E-03	NA	3.E-02	4.E-02
		Exposure Point Total		NA	NA	NA	NA		3.E-02	NA	5.E-02	8.E-02
		Surface Water (Rivers & Creeks) Wading	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	1.E-03	1.E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	8.E-03	8.E-03
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	5.E-04	5.E-04
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	8.E-04	8.E-04
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	2.E-02	2.E-02
		Exposure Point Total		NA	NA	NA	NA		NA	NA	3.E-02	3.E-02
		Surface Water (Potable Use)	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	3.E+00	NA	2.E-02	3.E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	1.E+00	NA	1.E-01	1.E+00
			Cobalt	NA	NA	NA	NA	Endocrine	3.E+00	NA	7.E-03	3.E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	2.E+00	NA	1.E-02	2.E+00
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	2.E+00	NA	3.E-01	2.E+00
		Exposure Point Total		NA	NA	NA	NA		1.E+01	NA	4.E-01	1.E+01
	Exposure Medium Total (Swimming, Potable Use)			NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
	Exposure Medium Total (Wading, Potable Use)			NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
Medium Total (Swimming, Potable Use)				NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
Medium Total (Wading, Potable Use)				NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01

TABLE 10.11.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Receptor Total (Surface Water [Swimming, Potable Use])				NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01
Receptor Total (Surface Water [Wading, Potable Use])				NA	NA	NA	NA		1.E+01	NA	5.E-01	1.E+01

Notes: HI = Hazard Index; NA = Not applicable or not available

	SW (swimming)	SW (wading)
Total Cardiovascular HI Across Media =	**3**	**3**
Total Dermal HI Across Media =	**3**	**3**
Total Endocrine HI Across Media =	**3**	**3**
Total Gastrointestinal HI Across Media =	**2**	**2**
Total Nervous HI Across Media =	**2**	**2**
Total Urinary HI Across Media =	1	1

	Total
Total Cardiovascular HI Across Media =	**3**
Total Dermal HI Across Media =	**3**
Total Endocrine HI Across Media =	**3**
Total Gastrointestinal HI Across Media =	**2**
Total Nervous HI Across Media =	**2**
Total Urinary HI Across Media =	1

TABLE 10.12.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	7E-02	NA	4E-03	7E-02
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	2E-02	4E-02
			Cobalt	NA	NA	NA	NA	Endocrine	6E-02	NA	1E-03	7E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	2E-03	5E-02
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	4E-02	NA	5E-02	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	8E-02	3E-01
		Surface Water (Rivers & Creeks) Wading	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	NA	NA	3E-03	3E-03
			Cadmium (water)	NA	NA	NA	NA	Urinary	NA	NA	2E-02	2E-02
			Cobalt	NA	NA	NA	NA	Endocrine	NA	NA	1E-03	1E-03
			Iron	NA	NA	NA	NA	Gastrointestinal	NA	NA	2E-03	2E-03
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	NA	NA	4E-02	4E-02
		Exposure Point Total		NA	NA	NA	NA		NA	NA	6E-02	6E-02
		Surface Water (Potable Use)	Arsenic	NA	NA	NA	NA	Cardiovascular, Dermal	6E+00	NA	2E-02	6E+00
			Cadmium (water)	NA	NA	NA	NA	Urinary	2E+00	NA	1E-01	2E+00
			Cobalt	NA	NA	NA	NA	Endocrine	5E+00	NA	9E-03	5E+00
			Iron	NA	NA	NA	NA	Gastrointestinal	4E+00	NA	2E-02	4E+00
			Manganese (non-diet)	NA	NA	NA	NA	Nervous	3E+00	NA	4E-01	4E+00
		Exposure Point Total		NA	NA	NA	NA		2E+01	NA	6E-01	2E+01
	Exposure Medium Total (Swimming, Potable Use)			NA	NA	NA	NA		2E+01	NA	6E-01	2E+01
	Exposure Medium Total (Wading, Potable Use)			NA	NA	NA	NA		2E+01	NA	6E-01	2E+01
Medium Total (Swimming, Potable Use)				NA	NA	NA	NA		2E+01	NA	6E-01	2E+01
Medium Total (Wading, Potable Use)				NA	NA	NA	NA		2E+01	NA	6E-01	2E+01

TABLE 10.12.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Receptor Total (Surface Water [Swimming, Potable Use])				NA	NA	NA	NA		2E+01	NA	6E-01	2E+01
Receptor Total (Surface Water [Wading, Potable Use])				NA	NA	NA	NA		2E+01	NA	6E-01	2E+01

Notes: HI = Hazard Index; NA = Not applicable or not available

	SW (swimming)	SW (wading)
Total Cardiovascular HI Across Media =	**6**	**6**
Total Dermal HI Across Media =	**6**	**6**
Total Endocrine HI Across Media =	**5**	**5**
Total Gastrointestinal HI Across Media =	**4**	**4**
Total Nervous HI Across Media =	**4**	**4**
Total Urinary HI Across Media =	**2**	**2**

	Total
Total Cardiovascular HI Across Media =	**6**
Total Dermal HI Across Media =	**6**
Total Endocrine HI Across Media =	**5**
Total Gastrointestinal HI Across Media =	**4**
Total Nervous HI Across Media =	**4**
Total Urinary HI Across Media =	**2**

TABLE 10.13.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Tar Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: General Public
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Arsenic	4E-06	NA	4E-07	4E-06	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		4E-06	NA	4E-07	4E-06		NA	NA	NA	NA
		Surface Water (Rivers & Creeks) Wading	Arsenic	NA	NA	3E-07	3E-07	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	3E-07	3E-07		NA	NA	NA	NA
		Surface Water (Potable Use)	Arsenic	7E-04	NA	3E-06	7E-04	---	NA	NA	NA	NA
			Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
			Manganese (non-diet)	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		7E-04	NA	3E-06	7E-04		NA	NA	NA	NA
	Exposure Medium Total (Swimming, Potable Use)			7E-04	NA	4E-06	7E-04		NA	NA	NA	NA
	Exposure Medium Total (Wading, Potable Use)			7E-04	NA	4E-06	7E-04		NA	NA	NA	NA
Medium Total (Swimming, Potable Use)				7E-04	NA	4E-06	7E-04		NA	NA	NA	NA
Medium Total (Wading, Potable Use)				7E-04	NA	4E-06	7E-04		NA	NA	NA	NA
Receptor Total (Surface Water [Swimming, Potable Use])				7E-04	NA	4E-06	7E-04		NA	NA	NA	NA
Receptor Total (Surface Water [Wading, Potable Use])				7E-04	NA	4E-06	7E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 10.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Barium	NA	NA	NA	NA	Urinary	5E-03	NA	2E-02	2E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-02	NA	1E-02	8E-02
		Exposure Point Total		NA	NA	NA	NA		7E-02	NA	3E-02	1E-01
		Surface Water (Potable Use)	Barium	NA	NA	NA	NA	Urinary	3E-02	NA	2E-03	3E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	4E-01	NA	2E-03	4E-01
		Exposure Point Total		NA	NA	NA	NA		4E-01	NA	4E-03	4E-01
		Surface Water (Sweat Lodge)	Barium	NA	NA	NA	NA	Urinary	1E-02	NA	3E-03	1E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	1E-01	NA	3E-03	1E-01
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	6E-03	2E-01
		Water Vapor (Sweat Lodge)	Barium	NA	NA	NA	NA	Developmental	NA	2E+00	NA	2E+00
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	2E+00	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		6E-01	2E+00	4E-02	3E+00
Medium Total				NA	NA	NA	NA		6E-01	2E+00	4E-02	3E+00
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01

TABLE 10.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00
		Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		8E-02	NA	NA	8E-02
		Semi-Aquatic Mammals Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-04	NA	NA	5E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	NA	2E+00

TABLE 10.14.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		4E+01	NA	NA	4E+01
		Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		4E+01	NA	7E-03	4E+01
Medium Total				NA	NA	NA	NA		4E+01	NA	7E-03	4E+01
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		4E+01	2E+00	5E-02	4E+01

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Dermal HI Across Media =	NA	NA	0.2
Total Developmental HI Across Media =	NA	**2**	NA
Total Gastrointestinal HI Across Media =	NA	0.6	1
Total Hematologic HI Across Media =	NA	NA	**10**
Total Immune HI Across Media =	NA	NA	**10**
Total Urinary HI Across Media =	NA	0.07	**29**
Total Whole Body HI Across Media =	NA	NA	0.2

	Total
Total Dermal HI Across Media =	0.2
Total Developmental HI Across Media =	**2**
Total Gastrointestinal HI Across Media =	**2**
Total Hematologic HI Across Media =	**10**
Total Immune HI Across Media =	**10**
Total Urinary HI Across Media =	**29**
Total Whole Body HI Across Media =	0.2

TABLE 10.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	2E-02	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	3E-01	NA	2E-02	3E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	3E-02	4E-01
		Surface Water (Potable Use)	Barium	NA	NA	NA	NA	Urinary	4E-02	NA	3E-03	4E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	5E-01	NA	2E-03	5E-01
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	5E-03	6E-01
		Surface Water (Sweat Lodge)	Barium	NA	NA	NA	NA	Urinary	5E-02	NA	5E-03	6E-02
			Iron	NA	NA	NA	NA	Gastrointestinal	7E-01	NA	4E-03	7E-01
		Exposure Point Total		NA	NA	NA	NA		7E-01	NA	9E-03	7E-01
		Water Vapor (Sweat Lodge)	Barium	NA	NA	NA	NA	Developmental	NA	2E+00	NA	2E+00
			Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	2E+00	NA	2E+00
	Exposure Medium Total			NA	NA	NA	NA		2E+00	2E+00	5E-02	4E+00
Medium Total				NA	NA	NA	NA		2E+00	2E+00	5E-02	4E+00
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		7E-01	NA	NA	7E-01
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		3E+00	NA	NA	3E+00

TABLE 10.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	NA	2E-01
		Semi-Aquatic Mammals Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		6E-01	NA	NA	6E-01
	Exposure Medium Total			NA	NA	NA	NA		4E+00	NA	NA	4E+00
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01
		Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	1E-02	1E-02
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	1E-02	9E+01
Medium Total				NA	NA	NA	NA		1E+02	NA	1E-02	1E+02
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				NA	NA	NA	NA		1E+02	2E+00	6E-02	1E+02

TABLE 10.15.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Dermal HI Across Media =	NA	NA	0.5
Total Developmental HI Across Media =	NA	**2**	NA
Total Gastrointestinal HI Across Media =	NA	**2**	**2**
Total Hematologic HI Across Media =	NA	NA	**24**
Total Immune HI Across Media =	NA	NA	**24**
Total Urinary HI Across Media =	NA	0.1	**68**
Total Whole Body HI Across Media =	NA	NA	0.5

	Total
Total Dermal HI Across Media =	0.5
Total Developmental HI Across Media =	**2**
Total Gastrointestinal HI Across Media =	**4**
Total Hematologic HI Across Media =	**24**
Total Immune HI Across Media =	**24**
Total Urinary HI Across Media =	**69**
Total Whole Body HI Across Media =	0.5

TABLE 10.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Surface Water (Potable Use)	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Surface Water (Sweat Lodge)	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Water Vapor (Sweat Lodge)	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Iron	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	0E+00	NA	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	0E+00	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	0E+00	0E+00	0E+00		NA	NA	NA	NA
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA

TABLE 10.16.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
Neosho River Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Semi-Aquatic Mammals Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	0E+00	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Receptor Total (Sediment + Swimming + Potable Use + Sweat Lodge + Aquatic Biota)				0E+00	0E+00	0E+00	0E+00		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

TABLE 10.17.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E-01	NA	1E-01	9E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	1E-01	1E+00
	Exposure Medium Total			NA	NA	NA	NA		1E+00	NA	1E-01	1E+00
Medium Total				NA	NA	NA	NA		1E+00	NA	1E-01	1E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Cadmium (water)	NA	NA	NA	NA	Urinary	2E-02	NA	1E-01	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E-01	NA	2E-02	2E-01
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	5E-03	1E-02
		Exposure Point Total		NA	NA	NA	NA		2E-01	NA	1E-01	3E-01
		Surface Water (Potable Use)	Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-02	1E-01
			Cobalt	NA	NA	NA	NA	Endocrine	9E-01	NA	2E-03	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	3E-02	NA	7E-04	3E-02
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	2E-02	1E+00
		Surface Water (Sweat Lodge)	Cadmium (water)	NA	NA	NA	NA	Urinary	5E-02	NA	2E-02	7E-02
			Cobalt	NA	NA	NA	NA	Endocrine	4E-01	NA	3E-03	4E-01
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	1E-03	1E-02
		Exposure Point Total		NA	NA	NA	NA		4E-01	NA	2E-02	5E-01

TABLE 10.17.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+00	NA	1E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	9E+00	NA	9E+00
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
		Exposure Point Total		NA	NA	NA	NA		NA	1E+01	NA	1E+01
	Exposure Medium Total			NA	NA	NA	NA		2E+00	1E+01	2E-01	1E+01
Medium Total				NA	NA	NA	NA		2E+00	1E+01	2E-01	1E+01
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	8E-02	NA	NA	8E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	2E-02	NA	NA	2E-02
			Nickel	NA	NA	NA	NA	Whole Body	6E-03	NA	NA	6E-03
			Silver	NA	NA	NA	NA	Dermal	7E-02	NA	NA	7E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	1E-01	NA	NA	1E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E-01	NA	NA	3E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	3E-02	NA	NA	3E-02
			Nickel	NA	NA	NA	NA	Whole Body	8E-03	NA	NA	8E-03
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-01	NA	NA	7E-01
		Exposure Point Total		NA	NA	NA	NA		1E+00	NA	NA	1E+00

TABLE 10.17.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	8E-03	NA	NA	8E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	5E-03	NA	NA	5E-03
			Nickel	NA	NA	NA	NA	Whole Body	2E-03	NA	NA	2E-03
			Silver	NA	NA	NA	NA	Dermal	1E-02	NA	NA	1E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-02	NA	NA	3E-02
		Exposure Point Total		NA	NA	NA	NA		8E-02	NA	NA	8E-02
		Semi-Aquatic Mammal Tissue Sitewide	Barium	0E+00	NA	NA	0E+00	Urinary	5E-04	NA	NA	5E-04
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E-01	NA	NA	2E-01
		Exposure Point Total		NA	NA	NA	NA		3E-01	NA	NA	3E-01
	Exposure Medium Total			NA	NA	NA	NA		2E+00	NA	NA	2E+00

TABLE 10.17.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (cont.)	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+01	NA	NA	3E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	9E-01	NA	NA	9E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-01	NA	NA	2E-01
			Silver	NA	NA	NA	NA	Dermal	6E-02	NA	NA	6E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	9E+00	NA	NA	9E+00
		Exposure Point Total		NA	NA	NA	NA		4E+01	NA	NA	4E+01
Surface Water/	Aquatic Biota	Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	7E-03	7E-03
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	7E-03	7E-03
	Exposure Medium Total			NA	NA	NA	NA		4E+01	NA	7E-03	4E+01
Medium Total				NA	NA	NA	NA		4E+01	NA	7E-03	4E+01
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				NA	NA	NA	NA		4E+01	1E+01	3E-01	6E+01

TABLE 10.17.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Dermal HI Across Media =	NA	NA	0.2
Total Endocrine HI Across Media =	NA	**2**	NA
Total Gastrointestinal HI Across Media =	NA	NA	1
Total Hematologic HI Across Media =	0.4	NA	**10**
Total Immune HI Across Media =	0.4	NA	**10**
Total Respiratory HI Across Media =	NA	**10**	NA
Total Urinary HI Across Media =	0.9	**2**	**29**
Total Whole Body HI Across Media =	NA	0.05	0.2

	Total
Total Dermal HI Across Media =	0.2
Total Endocrine HI Across Media =	**2**
Total Gastrointestinal HI Across Media =	1
Total Hematologic HI Across Media =	**10**
Total Immune HI Across Media =	**10**
Total Respiratory HI Across Media =	**10**
Total Urinary HI Across Media =	**32**
Total Whole Body HI Across Media =	0.2

TABLE 10.18.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	Urinary	3E+00	NA	2E-01	4E+00
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		5E+00	NA	2E-01	5E+00
	Exposure Medium Total			NA	NA	NA	NA		5E+00	NA	2E-01	5E+00
Medium Total				NA	NA	NA	NA		5E+00	NA	2E-01	5E+00
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Cadmium (water)	NA	NA	NA	NA	Urinary	1E-01	NA	1E-01	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	8E-01	NA	2E-02	8E-01
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	6E-03	3E-02
		Exposure Point Total		NA	NA	NA	NA		9E-01	NA	1E-01	1E+00
		Surface Water (Potable Use)	Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	2E-02	2E-01
			Cobalt	NA	NA	NA	NA	Endocrine	1E+00	NA	2E-03	1E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	8E-04	4E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	2E-02	2E+00
		Surface Water (Sweat Lodge)	Cadmium (water)	NA	NA	NA	NA	Urinary	2E-01	NA	3E-02	3E-01
			Cobalt	NA	NA	NA	NA	Endocrine	2E+00	NA	4E-03	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	5E-02	NA	2E-03	5E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	4E-02	2E+00

TABLE 10.18.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Cadmium (water)	NA	NA	NA	NA	Urinary	NA	1E+00	NA	1E+00
			Cobalt	NA	NA	NA	NA	Respiratory	NA	9E+00	NA	9E+00
			Nickel	NA	NA	NA	NA	Respiratory	NA	1E+00	NA	1E+00
		Exposure Point Total		NA	NA	NA	NA		NA	1E+01	NA	1E+01
	Exposure Medium Total			NA	NA	NA	NA		5E+00	1E+01	2E-01	2E+01
Medium Total				NA	NA	NA	NA		5E+00	1E+01	2E-01	2E+01
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	4E-02	NA	NA	4E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	2E-01	NA	NA	2E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	4E-02	NA	NA	4E-02
			Nickel	NA	NA	NA	NA	Whole Body	1E-02	NA	NA	1E-02
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	3E-01	NA	NA	3E-01
		Exposure Point Total		NA	NA	NA	NA		7E-01	NA	NA	7E-01
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	6E-01	NA	NA	6E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	2E-02	NA	NA	2E-02
			Silver	NA	NA	NA	NA	Dermal	1E-01	NA	NA	1E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+00	NA	NA	2E+00
		Exposure Point Total		NA	NA	NA	NA		4E+00	NA	NA	4E+00

TABLE 10.18.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	2E-02	NA	NA	2E-02
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	5E-02	NA	NA	5E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	1E-02	NA	NA	1E-02
			Nickel	NA	NA	NA	NA	Whole Body	5E-03	NA	NA	5E-03
			Silver	NA	NA	NA	NA	Dermal	3E-02	NA	NA	3E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	7E-02	NA	NA	7E-02
		Exposure Point Total		NA	NA	NA	NA		2E+00	NA	NA	2E+00
		Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	Urinary	1E-03	NA	NA	1E-03
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	1E-01	NA	NA	1E-01
			Copper	NA	NA	NA	NA	Gastrointestinal	8E-02	NA	NA	8E-02
			Nickel	NA	NA	NA	NA	Whole Body	4E-02	NA	NA	4E-02
			Zinc	NA	NA	NA	NA	Immune, Hematologic	4E-01	NA	NA	4E-01
		Exposure Point Total		NA	NA	NA	NA		8E-01	NA	NA	8E-01
	Exposure Medium Total			NA	NA	NA	NA		7E+00	NA	NA	7E+00
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	Urinary	5E-01	NA	NA	5E-01
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	7E+01	NA	NA	7E+01
			Copper	NA	NA	NA	NA	Gastrointestinal	2E+00	NA	NA	2E+00
			Nickel	NA	NA	NA	NA	Whole Body	4E-01	NA	NA	4E-01
			Silver	NA	NA	NA	NA	Dermal	2E-01	NA	NA	2E-01
			Zinc	NA	NA	NA	NA	Immune, Hematologic	2E+01	NA	NA	2E+01
		Exposure Point Total		NA	NA	NA	NA		9E+01	NA	NA	9E+01

TABLE 10.18.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	Urinary	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	Urinary	NA	NA	1E-02	1E-02
			Copper	NA	NA	NA	NA	Gastrointestinal	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	Whole Body	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	Immune, Hematologic	NA	NA	NA	NA
		Exposure Point Total		NA	NA	NA	NA		NA	NA	5E+00	5E+00
	Exposure Medium Total			NA	NA	NA	NA		9E+01	NA	5E+00	1E+02
Medium Total				NA	NA	NA	NA		1E+02	NA	5E+00	1E+02
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				NA	NA	NA	NA		1E+02	1E+01	5E+00	1E+02

Notes: HI = Hazard Index; NA = Not applicable or not available

	Sed	SW	Biota
Total Dermal HI Across Media =	NA	NA	**3**
Total Endocrine HI Across Media =	NA	**4**	NA
Total Gastrointestinal HI Across Media =	NA	NA	**2**
Total Hematologic HI Across Media =	**2**	NA	**26**
Total Immune HI Across Media =	**2**	NA	**24**
Total Respiratory HI Across Media =	NA	**10**	**3**
Total Urinary HI Across Media =	**4**	**2**	**68**
Total Whole Body HI Across Media =	NA	0.1	0.5

	Total
Total Dermal HI Across Media =	**3**
Total Endocrine HI Across Media =	**4**
Total Gastrointestinal HI Across Media =	**2**
Total Hematologic HI Across Media =	**28**
Total Immune HI Across Media =	**26**
Total Respiratory HI Across Media =	**13**
Total Urinary HI Across Media =	**74**
Total Whole Body HI Across Media =	0.6

TABLE 10.19.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment (Rivers & Creeks)	Sediment (Rivers & Creeks)	Sediment (0 to 12-inch deep)	Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks)	Surface Water (Rivers & Creeks) Swimming	Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Surface Water (Potable Use)	Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
		Surface Water (Sweat Lodge)	Cadmium (water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cobalt	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	0E+00	0E+00		NA	NA	NA	NA

TABLE 10.19.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water (Rivers & Creeks) (cont.)	Surface Water (Rivers & Creeks) (cont.)	Water Vapor (Sweat Lodge)	Cadmium (water)	NA	2E-05	NA	2E-05	---	NA	NA	NA	NA
			Cobalt	NA	5E-04	NA	5E-04	---	NA	NA	NA	NA
			Nickel	NA	3E-05	NA	3E-05	---	NA	NA	NA	NA
		Exposure Point Total		NA	5E-04	NA	5E-04		NA	NA	NA	NA
	Exposure Medium Total			0E+00	5E-04	0E+00	5E-04		NA	NA	NA	NA
Medium Total				0E+00	5E-04	0E+00	5E-04		NA	NA	NA	NA
Surface Water/ Sediment (Rivers & Creeks)	Aquatic Biota (Animal Tissue)	Fish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Shellfish Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA

TABLE 10.19.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Animal Tissue) (cont.)	Amphibian/Aquatic Reptile Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
		Semi-Aquatic Mammal Tissue Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	NA	0E+00		NA	NA	NA	NA
	Aquatic Biota (Plant Tissue)	Aquatic Plant (as Food) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Silver	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		0E+00	NA	NA	0E+00		NA	NA	NA	NA

TABLE 10.19.RME
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
Beaver Creek Watershed
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult/Child Aggregate

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Water/ Sediment (Rivers & Creeks) (cont.)	Aquatic Biota (Plant Tissue) (cont.)	Aquatic Plant (as Salve) Sitewide	Barium	NA	NA	NA	NA	---	NA	NA	NA	NA
			Cadmium (non-water)	NA	NA	NA	NA	---	NA	NA	NA	NA
			Copper	NA	NA	NA	NA	---	NA	NA	NA	NA
			Nickel	NA	NA	NA	NA	---	NA	NA	NA	NA
			Zinc	NA	NA	NA	NA	---	NA	NA	NA	NA
		Exposure Point Total		NA	NA	0E+00	0E+00		NA	NA	NA	NA
	Exposure Medium Total			0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Medium Total				0E+00	NA	0E+00	0E+00		NA	NA	NA	NA
Receptor Total (Sediment, Surface Water [Swimming, Potable Use, Sweat Lodge], Aquatic Biota [Fish, Shellfish, Amphibian/Aquatic Reptiles, Semi-Aquatic Mammals, Aquatic Plants])				0E+00	5E-04	0E+00	5E-04		NA	NA	NA	NA

Notes: HI = Hazard Index; NA = Not applicable or not available

Appendix C
Data Grouping and Sample Lists

Appendix C, Table 1a. Sediment Data Groupings and Sample Counts of the Data Sets used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping [a, b]	Description	Sample Counts
OU5_SED_All	All unsieved and sieved sediment samples collected from OU5[a].	463
OU5_SED_EC_US	Elm Creek unsieved sediment samples.	32
OU5_SED_EC_S	Elm Creek sieved sediment samples.	9
OU5_SED_TC_US	Tar Creek unsieved sediment samples.	101
OU5_SED_TC_S	Tar Creek sieved sediment samples.	98
OU5_SED_NR_US	Neosho River unsieved sediment samples.	17
OU5_SED_NR_S	Neosho River sieved sediment samples.	6
OU5_SED_BC_US	Beaver Creek unsieved sediment samples.	22
OU5_SED_BC_S	Beaver Creek sieved sediment samples.	16
OU5_SED_LC_US	Lost Creek unsieved sediment samples.	37
OU5_SED_LC_S	Lost Creek sieved sediment samples.	10
OU5_SED_LSR_US	Lower Spring River unsieved sediment samples.	48
OU5_SED_LSR_S	Lower Spring River sieved sediment samples.	67

Notes:

[a] All sediment samples (sitewide data grouping) were used to select COPCs in Tables 2.1a and 2.1b of Appendix B.

[b] EPCs were estimated for sieved and unsieved data sets separately for each watershed.

The higher EPC of the two data sets was used as the final EPC.

COPC = chemical of potential concern

EPC = exposure point concentration

HHRA = human health risk assessment

OU5 = Operable Unit 5

Appendix C, Table 1b. Surface Water Data Groupings and Sample Counts of the Data Sets used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping [a, b]	Description	Sample Counts
OU5_SW_All_T	All surface water samples (total)[c] collected from OU5[a].	2,207
OU5_SW_EC_T	Elm Creek surface water (total) samples.	47
OU5_SW_TC_T	Tar Creek surface water (total) samples.	1,396
OU5_SW_NR_T	Neosho River surface water (total) samples.	82
OU5_SW_BC_T	Beaver Creek surface water (total) samples.	326
OU5_SW_LC_T	Lost Creek surface water (total) samples.	69
OU5_SW_LSR_T	Lower Spring River surface water (total) samples.	287

Notes:

[a] All surface water samples (sitewide data grouping) were used to select COPCs in Tables 2.2a and 2.2b of Appendix B.

[b] EPCs were estimated separately for each watershed.

[c] Total metals = unfiltered metals

COPC = chemical of potential concern

EPC = exposure point concentration

HHRA = human health risk assessment

OU5 = Operable Unit 5

Appendix C, Table 1c. Biota Data Groupings and Sample Counts of the Datasets used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping [a, b, c]	Biota Type	Description	Sample Counts
OU5_FTE_All	Fish	All fish (game and non-game, total estimated) samples collected from OU5 [a] (Tribal Lifeway).	80
OU5_FTE_EC	Fish	Fish (game and non-game, total estimated) collected from Elm Creek (Tribal Lifeway).	22
OU5_FTE_TC	Fish	Fish (game and non-game, total estimated) collected from Tar Creek (Tribal Lifeway).	15
OU5_FTE_NR	Fish	Fish (game and non-game, total estimated) collected from Neosho River (Tribal Lifeway).	18
OU5_FTE_BC	Fish	Fish (game and non-game, total estimated) collected from Beaver Creek (Tribal Lifeway).	4
OU5_FTE_LC	Fish	Fish (game and non-game, total estimated) collected from Lost Creek (Tribal Lifeway).	7
OU5_FTE_LSR	Fish	Fish (game and non-game, total estimated) collected from Lower Spring River (Tribal Lifeway).	14
OU5_GFF_All	Fish	All game fish fillet samples collected from OU5[a] (General Public).	101
OU5_GFF_EC	Fish	Game fish fillet samples collected from Elm Creek (General Public).	24
OU5_GFF_TC	Fish	Game fish fillet samples collected from Tar Creek (General Public).	21
OU5_GFF_NR	Fish	Game fish fillet samples collected from Neosho River (General Public).	27
OU5_GFF_BC	Fish	Game fish fillet samples collected from Beaver Creek (General Public).	3
OU5_GFF_LC	Fish	Game fish fillet samples collected from Lost Creek (General Public).	6
OU5_GFF_LSR	Fish	Game fish fillet samples collected from Lower Spring River (General Public).	20
OU5_SF_All	Shellfish	All shellfish samples collected from OU5[a].	22
OU5_SF_NR	Shellfish	Shellfish samples collected from Neosho River.	1
OU5_SF_LSR	Shellfish	Shellfish samples collected from Lower Spring River (including Spring River).	21
OU5_AP_All	Plant	All arrowhead and duckweed plant samples collected from OU5[a] (plants as food).	17
OU5_AP_EC	Plant	Arrowhead and duckweed plant samples collected from Elm Creek (plants as food).	3
OU5_AP_TC	Plant	Arrowhead and duckweed plant samples collected from Tar Creek (plants as food).	3
OU5_AP_NR	Plant	Arrowhead and duckweed plant samples collected from Neosho River (plants as food).	1
OU5_AP_LC	Plant	Arrowhead and duckweed plant samples collected from Lost Creek (plants as food).	8
OU5_AP_LSR	Plant	Arrowhead and duckweed plant samples collected from Lower Spring River (plants as food).	2
OU5_APS_All	Plant	All arrowhead plant samples collected from OU5[a] (plant as salve).	11
OU5_APS_EC	Plant	Arrowhead plant samples collected from Elm Creek (plant as salve).	2
OU5_APS_TC	Plant	Arrowhead plant samples collected from Tar Creek (plant as salve).	2
OU5_APS_LC	Plant	Arrowhead plant samples collected from Lost Creek (plant as salve).	5
OU5_APS_LSR	Plant	Arrowhead plant samples collected from Lower Spring River (plant as salve).	2
OU5_AR_All	Amphibian	All amphibian/reptile (bullfrog) samples (discrete and composite) collected from OU5[a].	14
OU5_AR_TC	Amphibian	Amphibian/reptile (bullfrog) samples (discrete and composite) collected from Tar Creek.	2
OU5_AR_NR	Amphibian	Amphibian/reptile (bullfrog) samples (discrete and composite) collected from Neosho River.	4
OU5_AR_BC	Amphibian	Amphibian/reptile (bullfrog) samples (discrete and composite) collected from Beaver Creek.	4
OU5_AR_LC	Amphibian	Amphibian/reptile (bullfrog) samples (discrete and composite) collected from Lost Creek.	1
OU5_AR_LSR	Amphibian	Amphibian/reptile (bullfrog) samples (discrete and composite) collected from Lower Spring River.	3

Appendix C, Table 1c. Biota Data Groupings and Sample Counts of the Datasets used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping [a, b, c]	Biota Type	Description	Sample Counts
OU5_SAM_All	Semi-aquatic mammals	All semi-aquatic mammal (raccoon) samples collected from OU5[a].	19
OU5_SAM_EC	Semi-aquatic mammals	Semi-aquatic mammal (raccoon) samples collected from Elm Creek.	1
OU5_SAM_TC	Semi-aquatic mammals	Semi-aquatic mammal (raccoon) samples collected from Tar Creek.	3
OU5_SAM_NR	Semi-aquatic mammals	Semi-aquatic mammal (raccoon) samples collected from Neosho River.	6
OU5_SAM_BC	Semi-aquatic mammals	Semi-aquatic mammal (raccoon) samples collected from Beaver Creek.	3
OU5_SAM_LC	Semi-aquatic mammals	Semi-aquatic mammal (raccoon) samples collected from Lost Creek.	3
OU5_SAM_LSR	Semi-aquatic mammals	Semi-aquatic mammal (raccoon) samples collected from Lower Spring River.	3

Notes:

[a] All (sitewide) data groupings for each biota type were used to select COPCs in Tables 2.3 through 2.9 of Appendix B.

[b] EPCs were estimated using the "All" (sitewide) data groupings for each biota type.

[c] Evaluation of watershed-specific datasets is presented in Appendix F5.

COPC = chemical of potential concern

EPC = exposure point concentration

HHRA = human health risk assessment

OU5 = Operable Unit 5

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_EC_US	122_20060503	Elm Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	6023065043_20060503	Elm Creek	5/3/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_EC_US	123_20060503	Elm Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	124_20060503	Elm Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	6023065047_20060503	Elm Creek	5/3/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_EC_US	112_20060504	Elm Creek	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	6023065051_20060504	Elm Creek	5/4/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_EC_US	NR-07-SED-36_<2_20070710	Elm Creek	7/10/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_EC_US	MF2ZM5	Elm Creek	3/8/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZM3	Elm Creek	3/8/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZM1	Elm Creek	3/8/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZL9	Elm Creek	3/8/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZM9	Elm Creek	3/9/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZM7	Elm Creek	3/9/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZL5	Elm Creek	3/10/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZL7	Elm Creek	3/10/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZS9	Elm Creek	3/11/2009	0-8	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZT1	Elm Creek	3/11/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZT3	Elm Creek	3/11/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZT7	Elm Creek	3/19/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	MF2ZW0	Elm Creek	3/19/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-01	Elm Creek	9/19/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-02	Elm Creek	9/19/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-03	Elm Creek	9/19/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-04	Elm Creek	9/19/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-05	Elm Creek	9/19/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-06	Elm Creek	9/19/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-07	Elm Creek	9/20/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-08	Elm Creek	9/20/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-09	Elm Creek	9/20/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-10	Elm Creek	9/20/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_EC_US	EC-SD-AR-01	Elm Creek	10/31/2017	3-6	Unsieved	No
OU5_SED_All	OU5_SED_EC_S	365956094521400_20041020_0910	Elm Creek	10/20/2004	0.8	Sieved (63 µm)	Yes

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_EC_S	6023065041_20060503	Elm Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_EC_S	6023065042_20060503	Elm Creek	5/3/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_EC_S	6022917037_20060503	Elm Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_EC_S	6023065045_20060503	Elm Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_EC_S	6023065046_20060503	Elm Creek	5/3/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_EC_S	6023065049_20060504	Elm Creek	5/4/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_EC_S	6023065050_20060504	Elm Creek	5/4/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_EC_S	NR-07-SED-36_<250_20070710	Elm Creek	7/10/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20040304	Tar Creek	3/4/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20040328	Tar Creek	3/28/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20040709	Tar Creek	7/9/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20050523	Tar Creek	5/23/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185095_SD_20050523	Tar Creek	5/23/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20050524	Tar Creek	5/24/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185095_SD_20050524	Tar Creek	5/24/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20050613	Tar Creek	6/13/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20050915	Tar Creek	9/15/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185095_SD_20050915	Tar Creek	9/15/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20060425	Tar Creek	4/25/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	07185090_SD_20060429	Tar Creek	4/29/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	81_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	82_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	86_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	87_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	88_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	22_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	92_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	96_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	98_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	23_20060502	Tar Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	83_20060503	Tar Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	6023065078_20060503	Tar Creek	5/3/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	89_20060503	Tar Creek	5/3/2006	0-6	Unsieved	No

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_TC_US	90_20060503	Tar Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	6023065082_20060503	Tar Creek	5/3/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	93_20060503	Tar Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	94_20060503	Tar Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	95_20060503	Tar Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	84_20060504	Tar Creek	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	85_20060504	Tar Creek	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	6023065055_20060504	Tar Creek	5/4/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	97_20060504	Tar Creek	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	41_20060504	Tar Creek	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	TAR-103_<2_20070710	Tar Creek	7/10/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-21_<2_20070711	Tar Creek	7/11/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-57_<2_20070711	Tar Creek	7/11/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-61_<2_20070711	Tar Creek	7/11/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-33_<2_20070821	Tar Creek	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-34_<2_20070821	Tar Creek	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-60_<2_20070821	Tar Creek	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-71_<2_20070821	Tar Creek	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-04_<2_20070822	Tar Creek	8/22/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TAR-07-SED-68_<2_20070822	Tar Creek	8/22/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	MF2ZF5	Tar Creek	3/5/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZC5	Tar Creek	3/6/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZF1	Tar Creek	3/6/2009	0-10	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZC3	Tar Creek	3/6/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZE9	Tar Creek	3/6/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZE7	Tar Creek	3/6/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZK7	Tar Creek	3/7/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZD9	Tar Creek	3/7/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZB9	Tar Creek	3/17/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZA9	Tar Creek	3/17/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZB1	Tar Creek	3/17/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZF7	Tar Creek	3/18/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZB3	Tar Creek	3/18/2009	0-6	Unsieved	No

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_TC_US	MF2ZF9	Tar Creek	3/18/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZB5	Tar Creek	3/18/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZK5	Tar Creek	3/19/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZK1	Tar Creek	3/19/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZB7	Tar Creek	3/20/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZJ9	Tar Creek	3/20/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZJ7	Tar Creek	3/20/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZA1	Tar Creek	3/20/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZJ5	Tar Creek	3/25/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZA7	Tar Creek	3/25/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZJ3	Tar Creek	3/25/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZJ2	Tar Creek	3/26/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZH9	Tar Creek	3/26/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZG7	Tar Creek	3/27/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZG9	Tar Creek	3/27/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZH1	Tar Creek	3/28/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZH5	Tar Creek	3/28/2009	0-12	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	MF2ZH7	Tar Creek	3/28/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_US	6762-11	Tar Creek	4/7/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-12	Tar Creek	4/7/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-13	Tar Creek	4/7/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-14	Tar Creek	4/7/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-16	Tar Creek	4/7/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-17	Tar Creek	4/7/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-19	Tar Creek	4/7/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-20	Tar Creek	4/7/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-22	Tar Creek	4/7/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-23	Tar Creek	4/7/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-27	Tar Creek	4/7/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-28	Tar Creek	4/7/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-30	Tar Creek	4/7/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-31	Tar Creek	4/7/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-1	Tar Creek	4/8/2015	0-6	Sieved (2.00 mm)	No

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_TC_US	6762-2	Tar Creek	4/8/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-3	Tar Creek	4/8/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-4	Tar Creek	4/8/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-5	Tar Creek	4/8/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-6	Tar Creek	4/8/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-7	Tar Creek	4/8/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-10	Tar Creek	4/8/2015	6-12	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-9	Tar Creek	4/8/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	6762-32	Tar Creek	4/8/2015	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_TC_US	TC-SD-AR-01	Tar Creek	11/1/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_TC_S	365956094480500_20041020_0805	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	365955094505400_20041020_0830	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370101094514800_20041020_0930	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370100094514300_20041020_0940	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370100094512100_20041020_0950	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370153094511100_20041020_1005	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370245094510000_20041020_1020	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370245094515000_20041020_1035	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370245094503800_20041020_1045	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	365956094510800_20041020_1310	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	370034094514400_20041020_1340	Tar Creek	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 026_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 027_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 028_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 029_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 030_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 031_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 032_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 033_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 034_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 035_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 036_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 037_20050608	Tar Creek	6/8/2005	0-6	Sieved (250 µm)	Yes

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_TC_S	TCSD-038_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-039_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-040_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-041_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-042_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-043_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-044_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-045_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-046_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-047_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-048_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-049_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-050_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-051_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-052_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-053_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-054_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-055_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-056_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-057_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-058_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-059_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-060_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-061_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-062_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-063_20050609	Tar Creek	6/9/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-064_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-065_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-066_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-067_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-068_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-069_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-070_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_TC_S	TCSD-071_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-072_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-073_20050610	Tar Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD080_20050616	Tar Creek	6/16/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 096_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 097_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 098_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 099_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 100_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 103_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 107_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD 108_20050621	Tar Creek	6/21/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-111_20050622	Tar Creek	6/22/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-115_20050622	Tar Creek	6/22/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-120_20050622	Tar Creek	6/22/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-121_20050622	Tar Creek	6/22/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-123_20050622	Tar Creek	6/22/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TCSD-124_20050622	Tar Creek	6/22/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917066_20060502	Tar Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917067_20060502	Tar Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917068_20060502	Tar Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917031_20060502	Tar Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917069_20060502	Tar Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6023065076_20060503	Tar Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6023065077_20060503	Tar Creek	5/3/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6023065080_20060503	Tar Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6023065081_20060503	Tar Creek	5/3/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917030_20060503	Tar Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917029_20060504	Tar Creek	5/4/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6023065053_20060504	Tar Creek	5/4/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6023065054_20060504	Tar Creek	5/4/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	6022917032_20060504	Tar Creek	5/4/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-103_<250_20070710	Tar Creek	7/10/2007	0-8	Sieved (250 µm)	Yes

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-21_<250_20070711	Tar Creek	7/11/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-57_<250_20070711	Tar Creek	7/11/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-61_<250_20070711	Tar Creek	7/11/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-33_<250_20070821	Tar Creek	8/21/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-34_<250_20070821	Tar Creek	8/21/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-60_<250_20070821	Tar Creek	8/21/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-71_<250_20070821	Tar Creek	8/21/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-04_<250_20070822	Tar Creek	8/22/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_TC_S	TAR-07-SED-68_<250_20070822	Tar Creek	8/22/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_NR_US	07185190_SD_20040305	Neosho River	3/5/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	07185190_SD_20040330	Neosho River	3/30/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	371107_20050315	Neosho River	3/15/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	374295_20050510	Neosho River	5/10/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	07185190_SD_20050516	Neosho River	5/16/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	07185190_SD_20050525	Neosho River	5/25/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	376176_20050608	Neosho River	6/8/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	377789_20050630	Neosho River	6/30/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	07185190_SD_20050817	Neosho River	8/17/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	07185190_SD_20060501	Neosho River	5/1/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	6023065039_20060502	Neosho River	5/2/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_NR_US	80_20060502	Neosho River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	104_20060503	Neosho River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	103_20060503	Neosho River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	113_20060504	Neosho River	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_US	NR-07-SED-13_<2_20070821	Neosho River	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_NR_US	NR-SD-MS-02	Neosho River	10/30/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_NR_S	6023065037_20060502	Neosho River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_NR_S	6023065038_20060502	Neosho River	5/2/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_NR_S	6022917059_20060503	Neosho River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_NR_S	6022917060_20060503	Neosho River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_NR_S	6022917048_20060504	Neosho River	5/4/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_NR_S	NR-07-SED-13_<250_20070821	Neosho River	8/21/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_US	07188000_SD_20040304	Beaver Creek	3/4/2004	0-6	Unsieved	No

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_BC_US	07188000_SD_20040329	Beaver Creek	3/29/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	07188000_SD_20040820	Beaver Creek	8/20/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	07188000_SD_20050516	Beaver Creek	5/16/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	07188000_SD_20050927	Beaver Creek	9/27/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	07188000_SD_20060430	Beaver Creek	4/30/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	65_20060501	Beaver Creek	5/1/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	99_20060502	Beaver Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MSR-07-SED-72_<2_20070821	Beaver Creek	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_BC_US	MF2ZR1	Beaver Creek	3/8/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZQ9	Beaver Creek	3/8/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZQ7	Beaver Creek	3/8/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZQ1	Beaver Creek	3/9/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZQ3	Beaver Creek	3/10/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZQ5	Beaver Creek	3/10/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZP9	Beaver Creek	3/11/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZP7	Beaver Creek	3/11/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZP5	Beaver Creek	3/11/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	MF2ZP3	Beaver Creek	3/18/2009	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	RVR0004-0003SD	Beaver Creek	11/15/2011	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	RVR0004-0002SD	Beaver Creek	11/15/2011	0-6	Unsieved	No
OU5_SED_All	OU5_SED_BC_US	RVR0004-0001SD	Beaver Creek	11/15/2011	0-12	Unsieved	No
OU5_SED_All	OU5_SED_BC_S	TCSD-075_20050610	Beaver Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-076_20050610	Beaver Creek	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-128_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-129_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-131_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-132_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-136_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-137_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-138_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-139_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-140_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-141_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_BC_S	TCSD-142_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	TCSD-148_20050623	Beaver Creek	6/23/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	6022917025_20060502	Beaver Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_BC_S	MSR-07-SED-72_<250_20070821	Beaver Creek	8/21/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LC_US	208_20060501	Lost Creek	5/1/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	207_20060501	Lost Creek	5/1/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	66_20060502	Lost Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	67_20060502	Lost Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	68_20060502	Lost Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	71_20060502	Lost Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	72_20060502	Lost Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	73_20060502	Lost Creek	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	69_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	70_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	227_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	228_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	224_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	225_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	230_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	229_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	223_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	222_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	221_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	220_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	219_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	226_20060503	Lost Creek	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	231_20060504	Lost Creek	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-07-SED-39_<2_20070709	Lost Creek	7/9/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LC_US	LC-07-SED-16_<2_20070711	Lost Creek	7/11/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LC_US	LC-003_<2_20070822	Lost Creek	8/22/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-01	Lost Creek	9/21/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-02	Lost Creek	9/21/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-04	Lost Creek	9/21/2017	0-12	Unsieved	No

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_LC_US	LC-SD-03	Lost Creek	9/21/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-07	Lost Creek	10/30/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-05	Lost Creek	10/30/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-06	Lost Creek	10/30/2017	0-12	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-08	Lost Creek	10/31/2017	3-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-09	Lost Creek	10/31/2017	3-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-10	Lost Creek	10/31/2017	3-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_US	LC-SD-AR-01	Lost Creek	10/31/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LC_S	6022917007_20060501	Lost Creek	5/1/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	6022917003_20060502	Lost Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	6022917006_20060502	Lost Creek	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	6022917004_20060503	Lost Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	6022917005_20060503	Lost Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	6022917008_20060503	Lost Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	6022917009_20060503	Lost Creek	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	LC-07-SED-39_<250_20070709	Lost Creek	7/9/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	LC-07-SED-16_<250_20070711	Lost Creek	7/11/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LC_S	LC-003_<250_20070822	Lost Creek	8/22/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_US	07188180_SD_20040305	Lower Spring River	3/5/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	07188180_SD_20040330	Lower Spring River	3/30/2004	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	07188180_SD_20050516	Lower Spring River	5/16/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	07188180_SD_20050525	Lower Spring River	5/25/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	07188180_SD_20050817	Lower Spring River	8/17/2005	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	07188180_SD_20060501	Lower Spring River	5/1/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	6023065063_20060502	Lower Spring River	5/2/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LSR_US	78_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	6023065067_20060502	Lower Spring River	5/2/2006	0-6	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LSR_US	79_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	102_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	100_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	101_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	212_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	211_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_LSR_US	210_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	209_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	19_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	20_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	21_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	24_20060502	Lower Spring River	5/2/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	125_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	126_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	106_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	107_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	108_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	109_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	111_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	25_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	27_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	28_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	26_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	129_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	110_20060503	Lower Spring River	5/3/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	119_20060504	Lower Spring River	5/4/2006	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	0704060-01_20070306	Lower Spring River	3/6/2007	7.62-10.16	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	MSR-07-SED-32_<2_20070709	Lower Spring River	7/9/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LSR_US	MSR-07-SED-22_<2_20070821	Lower Spring River	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LSR_US	MSR-07-SED-62_<2_20070821	Lower Spring River	8/21/2007	0-8	Sieved (2.00 mm)	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-MS-01	Lower Spring River	9/18/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-MS-02	Lower Spring River	9/21/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-MS-03	Lower Spring River	9/25/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-MS-04	Lower Spring River	9/28/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-AR-01	Lower Spring River	10/31/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-01	Lower Spring River	11/1/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-02	Lower Spring River	11/1/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-03	Lower Spring River	11/1/2017	0-6	Unsieved	No
OU5_SED_All	OU5_SED_LSR_US	LS-SD-MS-05	Lower Spring River	11/1/2017	0-6	Unsieved	No

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_LSR_S	370424094442700_20041019_1135	Lower Spring River	10/19/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370224094442600_20041019_1210	Lower Spring River	10/19/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370144094440500_20041019_1330	Lower Spring River	10/19/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370127094442800_20041019_1350	Lower Spring River	10/19/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370121094444200_20041019_1410	Lower Spring River	10/19/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370109094453100_20041019_1430	Lower Spring River	10/19/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370220094453100_20041019_1445	Lower Spring River	10/19/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370213094474200_20041020_1420	Lower Spring River	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370245094474400_20041020_1435	Lower Spring River	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370215094463600_20041020_1455	Lower Spring River	10/20/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370444094442600_20041021_1215	Lower Spring River	10/21/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370505094453500_20041021_1250	Lower Spring River	10/21/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370523094455100_20041021_1315	Lower Spring River	10/21/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370616094463600_20041021_1335	Lower Spring River	10/21/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370451094463700_20041021_1400	Lower Spring River	10/21/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370512094484800_20041021_1420	Lower Spring River	10/21/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	365955094424100_20041108_1335	Lower Spring River	11/8/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370114094431600_20041108_1420	Lower Spring River	11/8/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370237094433400_20041108_1540	Lower Spring River	11/8/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370007094421100_20041108_1630	Lower Spring River	11/8/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	BRSH1449050	Lower Spring River	11/30/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	BRSH1449051	Lower Spring River	11/30/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	BRSH1449052	Lower Spring River	11/30/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	BRSH1464430	Lower Spring River	11/30/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	BRSH1464431	Lower Spring River	11/30/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	BRSH1464432	Lower Spring River	11/30/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	WLW1449768	Lower Spring River	12/1/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	WLW1449769	Lower Spring River	12/1/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	WLW1449770	Lower Spring River	12/1/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	WLW1464459	Lower Spring River	12/1/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	WLW1464460	Lower Spring River	12/1/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	WLW1464480	Lower Spring River	12/1/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370803094464600_20041215_1150	Lower Spring River	12/15/2004	0.8	Sieved (63 µm)	Yes

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_LSR_S	370706094472600_20041215_1210	Lower Spring River	12/15/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370432094494000_20041215_1240	Lower Spring River	12/15/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	370617094444200_20041215_1305	Lower Spring River	12/15/2004	0.8	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	SPRNG6449441	Lower Spring River	12/30/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	SPRNG6449442	Lower Spring River	12/30/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	SPRNG6449443	Lower Spring River	12/30/2004	5 cm	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	SPRNG6464462	Lower Spring River	12/30/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	SPRNG6464463	Lower Spring River	12/30/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	SPRNG6464464	Lower Spring River	12/30/2004	5 cm	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	TCSD-074_20050610	Lower Spring River	6/10/2005	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6023065061_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6023065062_20060502	Lower Spring River	5/2/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6023065065_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6023065066_20060502	Lower Spring River	5/2/2006	0-6	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917072_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917073_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917017_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917021_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917080_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917022_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917065_20060502	Lower Spring River	5/2/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917071_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917052_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917054_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917079_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917081_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917036_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917064_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917026_20060503	Lower Spring River	5/3/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	6022917053_20060504	Lower Spring River	5/4/2006	0-6	Sieved (63 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	0704060-13_20070306	Lower Spring River	3/6/2007	7.62-10.16	Sieved (63 µm)	Yes

Appendix C, Table 2a. Sediment Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Watershed	Sample Date	Collection Depth (inches)	Sample Preparation	Included in Sieved Data Grouping?[c]
OU5_SED_All	OU5_SED_LSR_S	MSR-07-SED-32_<250_20070709	Lower Spring River	7/9/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	MSR-07-SED-22_<250_20070821	Lower Spring River	8/21/2007	0-8	Sieved (250 µm)	Yes
OU5_SED_All	OU5_SED_LSR_S	MSR-07-SED-62_<250_20070821	Lower Spring River	8/21/2007	0-8	Sieved (250 µm)	Yes

Notes:

[a] All sediment samples (sitewide data grouping) were used to select COPCs in Tables 2.1a and 2.1b of Appendix B.

[b] EPCs were estimated for sieved and unsieved datasets separately for each watershed.

The higher EPC of the two datasets was used as the final EPC.

[c] Sieved samples (63 and 250 µm) were grouped into sieved data groupings.

µm = micrometer

COPC = chemical of potential concern

EPC = exposure point concentration

HHRA = human health risk assessment

mm = millimeter

OU5 = Operable Unit 5

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20050311	EC-E30	Elm Creek	03/11/05
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20050408	EC-E30	Elm Creek	04/08/05
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20050506	EC-E30	Elm Creek	05/06/05
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20050602	EC-E30	Elm Creek	06/02/05
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20050706	EC-E30	Elm Creek	07/06/05
OU5_SW_All_T	OU5_SW_EC_T	07185025_WS_20050715	07185025	Elm Creek	07/15/05
OU5_SW_All_T	OU5_SW_EC_T	1122_20060503	NR-103	Elm Creek	05/03/06
OU5_SW_All_T	OU5_SW_EC_T	1123_20060503	NR-104	Elm Creek	05/03/06
OU5_SW_All_T	OU5_SW_EC_T	1124_20060503	NR-105	Elm Creek	05/03/06
OU5_SW_All_T	OU5_SW_EC_T	1121_20060504	NR-102	Elm Creek	05/04/06
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20060505	EC-E30	Elm Creek	05/05/06
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20061204	EC-E30	Elm Creek	12/04/06
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20070105	EC-E30	Elm Creek	01/05/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20070202	EC-E30	Elm Creek	02/02/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20070302	EC-E30	Elm Creek	03/02/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20070406	EC-E30	Elm Creek	04/06/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20070504	EC-E30	Elm Creek	05/04/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20070601	EC-E30	Elm Creek	06/01/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20070706	EC-E30	Elm Creek	07/06/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20071005	EC-E30	Elm Creek	10/05/07
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080108	EC-E30	Elm Creek	01/08/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080201	EC-E30	Elm Creek	02/01/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080307	EC-E30	Elm Creek	03/07/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080404	EC-E30	Elm Creek	04/04/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080509	EC-E30	Elm Creek	05/09/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080606	EC-E30	Elm Creek	06/06/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080710	EC-E30	Elm Creek	07/10/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080808	EC-E30	Elm Creek	08/08/08
OU5_SW_All_T	OU5_SW_EC_T	EC-E30_20080905	EC-E30	Elm Creek	09/05/08
OU5_SW_All_T	OU5_SW_EC_T	MF2ZM0	RVR0003-0004SW	Elm Creek	03/08/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZM2	RVR0003-0005SW	Elm Creek	03/08/09

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_EC_T	MF2ZM4	RVR0003-0006SW	Elm Creek	03/08/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZM6	RVR0003-0007SW	Elm Creek	03/08/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZL4	RVR0003-0001SW	Elm Creek	03/09/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZM8	RVR0003-0008SW	Elm Creek	03/09/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZN0	RVR0003-0009SW	Elm Creek	03/09/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZL8	RVR0003-0003SW	Elm Creek	03/10/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZL6	RVR0003-0002SW	Elm Creek	03/10/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZT4	RVR0003-0012SW	Elm Creek	03/11/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZT2	RVR0003-0011SW	Elm Creek	03/11/09
OU5_SW_All_T	OU5_SW_EC_T	MF2ZT0	RVR0003-0010SW	Elm Creek	03/11/09
OU5_SW_All_T	OU5_SW_EC_T	RVR0003-0014SW	RVR0003-0014SW	Elm Creek	03/19/09
OU5_SW_All_T	OU5_SW_EC_T	RVR0003-0013SW	RVR0003-0013SW	Elm Creek	03/19/09
OU5_SW_All_T	OU5_SW_EC_T	EC-SW-FS-01	EC FS 01	Elm Creek	07/13/17
OU5_SW_All_T	OU5_SW_EC_T	EC-SW-FS-02	EC FS 02	Elm Creek	07/24/17
OU5_SW_All_T	OU5_SW_EC_T	EC-SW-FS-03	EC FS 03	Elm Creek	07/24/17
OU5_SW_All_T	OU5_SW_EC_T	EC-SW-AR-01	EC AR 01	Elm Creek	10/31/17
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_19000101	MR-SB (original)	Tar Creek	01/02/00
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_19000101	MR-SB	Tar Creek	01/02/00
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_19000101	TC-E20	Tar Creek	01/02/00
OU5_SW_All_T	OU5_SW_TC_T	UT-R_19000101	UT-R	Tar Creek	01/02/00
OU5_SW_All_T	OU5_SW_TC_T	07185095_WS_20000315	07185095	Tar Creek	03/15/00
OU5_SW_All_T	OU5_SW_TC_T	07185090_WS_20000315	07185090	Tar Creek	03/15/00
OU5_SW_All_T	OU5_SW_TC_T	07185095_WS_20000412	07185095	Tar Creek	04/12/00
OU5_SW_All_T	OU5_SW_TC_T	07185090_WS_20000412	07185090	Tar Creek	04/12/00
OU5_SW_All_T	OU5_SW_TC_T	07185090_WS_20000516	07185090	Tar Creek	05/16/00
OU5_SW_All_T	OU5_SW_TC_T	07185095_WS_20000517	07185095	Tar Creek	05/17/00
OU5_SW_All_T	OU5_SW_TC_T	07185095_WS_20000621	07185095	Tar Creek	06/21/00
OU5_SW_All_T	OU5_SW_TC_T	07185090_WS_20000622	07185090	Tar Creek	06/22/00
OU5_SW_All_T	OU5_SW_TC_T	07185095_WS_20000712	07185095	Tar Creek	07/12/00
OU5_SW_All_T	OU5_SW_TC_T	07185090_WS_20000712	07185090	Tar Creek	07/12/00
OU5_SW_All_T	OU5_SW_TC_T	07185095_WS_20000808	07185095	Tar Creek	08/08/00

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	07185090_WS_20000808	07185090	Tar Creek	08/08/00
OU5_SW_All_T	OU5_SW_TC_T	348058_20040304	07185090	Tar Creek	03/04/04
OU5_SW_All_T	OU5_SW_TC_T	348059_20040304	07185095	Tar Creek	03/04/04
OU5_SW_All_T	OU5_SW_TC_T	349165_20040328	07185095	Tar Creek	03/28/04
OU5_SW_All_T	OU5_SW_TC_T	349166_20040328	07185090	Tar Creek	03/28/04
OU5_SW_All_T	OU5_SW_TC_T	351319_20040505	07185100	Tar Creek	05/05/04
OU5_SW_All_T	OU5_SW_TC_T	351320_20040505	07185095	Tar Creek	05/05/04
OU5_SW_All_T	OU5_SW_TC_T	351322_20040506	07185090	Tar Creek	05/06/04
OU5_SW_All_T	OU5_SW_TC_T	351323_20040506	07185088	Tar Creek	05/06/04
OU5_SW_All_T	OU5_SW_TC_T	351324_20040506	071850870	Tar Creek	05/06/04
OU5_SW_All_T	OU5_SW_TC_T	351325_20040506	071850825	Tar Creek	05/06/04
OU5_SW_All_T	OU5_SW_TC_T	351327_20040506	071850815	Tar Creek	05/06/04
OU5_SW_All_T	OU5_SW_TC_T	353487_20040609	07185100	Tar Creek	06/09/04
OU5_SW_All_T	OU5_SW_TC_T	353488_20040609	07185095	Tar Creek	06/09/04
OU5_SW_All_T	OU5_SW_TC_T	353492_20040609	07185090	Tar Creek	06/09/04
OU5_SW_All_T	OU5_SW_TC_T	353493_20040610	07185088	Tar Creek	06/10/04
OU5_SW_All_T	OU5_SW_TC_T	353495_20040610	071850870	Tar Creek	06/10/04
OU5_SW_All_T	OU5_SW_TC_T	353496_20040610	071850825	Tar Creek	06/10/04
OU5_SW_All_T	OU5_SW_TC_T	353497_20040610	071850815	Tar Creek	06/10/04
OU5_SW_All_T	OU5_SW_TC_T	353580_20040614	07185095	Tar Creek	06/14/04
OU5_SW_All_T	OU5_SW_TC_T	355438_20040709	07185095	Tar Creek	07/09/04
OU5_SW_All_T	OU5_SW_TC_T	355439_20040709	07185090	Tar Creek	07/09/04
OU5_SW_All_T	OU5_SW_TC_T	356464_20040720	07185100	Tar Creek	07/20/04
OU5_SW_All_T	OU5_SW_TC_T	356465_20040720	07185095	Tar Creek	07/20/04
OU5_SW_All_T	OU5_SW_TC_T	356467_20040720	07185090	Tar Creek	07/20/04
OU5_SW_All_T	OU5_SW_TC_T	356469_20040721	07185088	Tar Creek	07/21/04
OU5_SW_All_T	OU5_SW_TC_T	356472_20040721	071850870	Tar Creek	07/21/04
OU5_SW_All_T	OU5_SW_TC_T	356475_20040721	071850825	Tar Creek	07/21/04
OU5_SW_All_T	OU5_SW_TC_T	356476_20040721	071850815	Tar Creek	07/21/04
OU5_SW_All_T	OU5_SW_TC_T	357684_20040803	07185100	Tar Creek	08/03/04
OU5_SW_All_T	OU5_SW_TC_T	357686_20040803	07185095	Tar Creek	08/03/04

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	357689_20040803	07185090	Tar Creek	08/03/04
OU5_SW_All_T	OU5_SW_TC_T	357690_20040804	07185088	Tar Creek	08/04/04
OU5_SW_All_T	OU5_SW_TC_T	357693_20040804	071850870	Tar Creek	08/04/04
OU5_SW_All_T	OU5_SW_TC_T	357695_20040804	071850825	Tar Creek	08/04/04
OU5_SW_All_T	OU5_SW_TC_T	357697_20040804	071850815	Tar Creek	08/04/04
OU5_SW_All_T	OU5_SW_TC_T	359692_20040831	07185100	Tar Creek	08/31/04
OU5_SW_All_T	OU5_SW_TC_T	359693_20040831	07185095	Tar Creek	08/31/04
OU5_SW_All_T	OU5_SW_TC_T	359697_20040831	07185090	Tar Creek	08/31/04
OU5_SW_All_T	OU5_SW_TC_T	359701_20040901	07185088	Tar Creek	09/01/04
OU5_SW_All_T	OU5_SW_TC_T	359703_20040901	071850870	Tar Creek	09/01/04
OU5_SW_All_T	OU5_SW_TC_T	359704_20040901	071850825	Tar Creek	09/01/04
OU5_SW_All_T	OU5_SW_TC_T	359705_20040901	071850815	Tar Creek	09/01/04
OU5_SW_All_T	OU5_SW_TC_T	1373_20040909	07185095	Tar Creek	09/09/04
OU5_SW_All_T	OU5_SW_TC_T	7185090.1_20040909	07185090	Tar Creek	09/09/04
OU5_SW_All_T	OU5_SW_TC_T	1375_20040910	07185095	Tar Creek	09/10/04
OU5_SW_All_T	OU5_SW_TC_T	7185090.3_20040910	07185090	Tar Creek	09/10/04
OU5_SW_All_T	OU5_SW_TC_T	360597_20040914	07185100	Tar Creek	09/14/04
OU5_SW_All_T	OU5_SW_TC_T	360598_20040914	07185095	Tar Creek	09/14/04
OU5_SW_All_T	OU5_SW_TC_T	360601_20040914	07185090	Tar Creek	09/14/04
OU5_SW_All_T	OU5_SW_TC_T	360603_20040915	07185088	Tar Creek	09/15/04
OU5_SW_All_T	OU5_SW_TC_T	360605_20040915	071850870	Tar Creek	09/15/04
OU5_SW_All_T	OU5_SW_TC_T	360606_20040915	071850825	Tar Creek	09/15/04
OU5_SW_All_T	OU5_SW_TC_T	360608_20040915	071850815	Tar Creek	09/15/04
OU5_SW_All_T	OU5_SW_TC_T	361387_20040928	07185100	Tar Creek	09/28/04
OU5_SW_All_T	OU5_SW_TC_T	361388_20040928	07185095	Tar Creek	09/28/04
OU5_SW_All_T	OU5_SW_TC_T	361391_20040928	07185090	Tar Creek	09/28/04
OU5_SW_All_T	OU5_SW_TC_T	361395_20040929	07185088	Tar Creek	09/29/04
OU5_SW_All_T	OU5_SW_TC_T	361397_20040929	071850870	Tar Creek	09/29/04
OU5_SW_All_T	OU5_SW_TC_T	361398_20040929	071850825	Tar Creek	09/29/04
OU5_SW_All_T	OU5_SW_TC_T	361399_20040929	071850815	Tar Creek	09/29/04
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20041003	MR-UTD	Tar Creek	10/03/04

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20041003	MR-UTU	Tar Creek	10/03/04
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20041003	M-SA	Tar Creek	10/03/04
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20041003	MR-SB (original)	Tar Creek	10/03/04
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20041003	MR-SC	Tar Creek	10/03/04
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20041105	MR-UTD	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20041105	MR-UTU	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20041105	M-SA	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20041105	MR-SB (original)	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20041105	MR-SC	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20041105	TC-22	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20041105	TC-R	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20041105	TC-US69	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20041105	TC-D	Tar Creek	11/05/04
OU5_SW_All_T	OU5_SW_TC_T	363791_20041109	07185100	Tar Creek	11/09/04
OU5_SW_All_T	OU5_SW_TC_T	363792_20041109	07185095	Tar Creek	11/09/04
OU5_SW_All_T	OU5_SW_TC_T	363796_20041109	07185090	Tar Creek	11/09/04
OU5_SW_All_T	OU5_SW_TC_T	363797_20041109	07185088	Tar Creek	11/09/04
OU5_SW_All_T	OU5_SW_TC_T	363803_20041110	071850870	Tar Creek	11/10/04
OU5_SW_All_T	OU5_SW_TC_T	363804_20041110	071850825	Tar Creek	11/10/04
OU5_SW_All_T	OU5_SW_TC_T	363805_20041110	071850815	Tar Creek	11/10/04
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20041210	TC-22	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20041210	TC-R	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20041210	UT-R	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20041210	MR-UTD	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20041210	MR-UTU	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20041210	M-SA	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20041210	MR-SB (original)	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20041210	MR-SC	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20041210	TC-US69	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20041210	TC-D	Tar Creek	12/10/04
OU5_SW_All_T	OU5_SW_TC_T	366882_20050105	07185095	Tar Creek	01/05/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	366883_20050105	07185090	Tar Creek	01/05/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050107	TC-22	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050107	MR-SB (original)	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050107	MR-UTU	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050107	TC-R	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050107	UT-R	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050107	MR-UTD	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050107	M-SA	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050107	TC-US69	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20050107	MR-SC	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050107	TC-D	Tar Creek	01/07/05
OU5_SW_All_T	OU5_SW_TC_T	TCM11105WS	TCM	Tar Creek	01/11/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL11105WS	TCSL	Tar Creek	01/11/05
OU5_SW_All_T	OU5_SW_TC_T	W1-W9_20050119	HSPH-TC-01	Tar Creek	01/19/05
OU5_SW_All_T	OU5_SW_TC_T	W100-W108_20050120	HSPH-TC-08	Tar Creek	01/20/05
OU5_SW_All_T	OU5_SW_TC_T	W10-W18_20050120	HSPH-TC-02	Tar Creek	01/20/05
OU5_SW_All_T	OU5_SW_TC_T	W22-W30_20050120	HSPH-TC-03	Tar Creek	01/20/05
OU5_SW_All_T	OU5_SW_TC_T	W40-W48_20050120	HSPH-TC-04	Tar Creek	01/20/05
OU5_SW_All_T	OU5_SW_TC_T	W67-W75_20050120	HSPH-TC-05	Tar Creek	01/20/05
OU5_SW_All_T	OU5_SW_TC_T	W76-W84_20050120	HSPH-TC-06	Tar Creek	01/20/05
OU5_SW_All_T	OU5_SW_TC_T	W91-W99_20050120	HSPH-TC-07	Tar Creek	01/20/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050211	MR-SB (original)	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050211	UT-R	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050211	TC-22	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050211	MR-UTD	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050211	TC-US69	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050211	MR-UTU	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050211	TC-R	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050211	M-SA	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050211	TC-D	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20050211	MR-SC	Tar Creek	02/11/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20050211	TC-E20	Tar Creek	02/11/05
OU5_SW_All_T	OU5_SW_TC_T	TCM21605WS	TCM	Tar Creek	02/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL21605WS	TCSL	Tar Creek	02/16/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050311	TC-22	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050311	TC-R	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050311	UT-R	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050311	MR-UTD	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050311	TC-US69	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050311	MR-UTU	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050311	TC-D	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050311	M-SA	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050311	MR-SB (original)	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20050311	LC-Conf	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20050311	MR-SC	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20050311	TC-Conf	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20050311	TC-E20	Tar Creek	03/11/05
OU5_SW_All_T	OU5_SW_TC_T	371072_20050315	07185100	Tar Creek	03/15/05
OU5_SW_All_T	OU5_SW_TC_T	371074_20050315	07185095	Tar Creek	03/15/05
OU5_SW_All_T	OU5_SW_TC_T	371078_20050315	07185090	Tar Creek	03/15/05
OU5_SW_All_T	OU5_SW_TC_T	371081_20050316	07185088	Tar Creek	03/16/05
OU5_SW_All_T	OU5_SW_TC_T	371084_20050316	071850870	Tar Creek	03/16/05
OU5_SW_All_T	OU5_SW_TC_T	371085_20050316	071850825	Tar Creek	03/16/05
OU5_SW_All_T	OU5_SW_TC_T	371086_20050316	071850815	Tar Creek	03/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCM31705WS	TCM	Tar Creek	03/17/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL31705WS	TCSL	Tar Creek	03/17/05
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20050407	Garrett	Tar Creek	04/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050408	TC-22	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050408	TC-R	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050408	MR-UTD	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050408	UT-R	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050408	MR-UTU	Tar Creek	04/08/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050408	M-SA	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050408	TC-US69	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050408	MR-SB (original)	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20050408	MR-SC	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050408	TC-D	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20050408	LC-Conf	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20050408	TC-Conf	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20050408	TC-E20	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20050408	TC-US166	Tar Creek	04/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCM041805SW	TCM	Tar Creek	04/18/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL041805SW	TCSL	Tar Creek	04/18/05
OU5_SW_All_T	OU5_SW_TC_T	W112-W121_20050503	HSPH-TC-09	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W125-W134_20050503	HSPH-TC-10	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W135-W144_20050503	HSPH-TC-11	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W145-W154_20050503	HSPH-TC-12	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W165-W174_20050503	HSPH-TC-13	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W195-W204_20050503	HSPH-TC-14	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W225-W234_20050503	HSPH-TC-15	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W235-W244_20050503	HSPH-TC-16	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W248-W257_20050503	HSPH-TC-17	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W258-W267_20050503	HSPH-TC-18	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W278-W287_20050503	HSPH-TC-19	Tar Creek	05/03/05
OU5_SW_All_T	OU5_SW_TC_T	W288-W297_20050504	HSPH-TC-20	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W308-W317_20050504	HSPH-TC-21	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W332-W341_20050504	HSPH-TC-22	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W354-W363_20050504	HSPH-TC-23	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W364-W373_20050504	HSPH-LC-01	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W374-W383_20050504	HSPH-LC-02	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W384-W393_20050504	HSPH-TC-24	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W394-W403_20050504	HSPH-TC-25	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W407-W416_20050504	HSPH-LC-03	Tar Creek	05/04/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	W417-W426_20050504	HSPH-LC-04	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	W427-W436_20050504	HSPH-TC-26	Tar Creek	05/04/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050506	TC-22	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050506	TC-R	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050506	UT-R	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050506	TC-US69	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050506	MR-UTD	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050506	TC-D	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050506	MR-UTU	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20050506	LC-Conf	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050506	M-SA	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20050506	TC-Conf	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20050506	TC-E20	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SC_20050506	MR-SC	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050506	MR-SB (original)	Tar Creek	05/06/05
OU5_SW_All_T	OU5_SW_TC_T	374263_20050510	07185100	Tar Creek	05/10/05
OU5_SW_All_T	OU5_SW_TC_T	374265_20050511	07185095	Tar Creek	05/11/05
OU5_SW_All_T	OU5_SW_TC_T	374267_20050511	07185090	Tar Creek	05/11/05
OU5_SW_All_T	OU5_SW_TC_T	374269_20050511	07185088	Tar Creek	05/11/05
OU5_SW_All_T	OU5_SW_TC_T	374272_20050511	071850870	Tar Creek	05/11/05
OU5_SW_All_T	OU5_SW_TC_T	374273_20050511	071850825	Tar Creek	05/11/05
OU5_SW_All_T	OU5_SW_TC_T	374274_20050511	071850815	Tar Creek	05/11/05
OU5_SW_All_T	OU5_SW_TC_T	TCM051705SW	TCM	Tar Creek	05/17/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL051705SW	TCSL	Tar Creek	05/17/05
OU5_SW_All_T	OU5_SW_TC_T	375013_20050523	07185090	Tar Creek	05/23/05
OU5_SW_All_T	OU5_SW_TC_T	375014_20050523	07185095	Tar Creek	05/23/05
OU5_SW_All_T	OU5_SW_TC_T	375311_20050524	07185090	Tar Creek	05/24/05
OU5_SW_All_T	OU5_SW_TC_T	375312_20050524	07185095	Tar Creek	05/24/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050602	TC-22	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050602	TC-R	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050602	UT-R	Tar Creek	06/02/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050602	MR-UTD	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050602	TC-US69	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050602	MR-UTU	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050602	M-SA	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050602	TC-D	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20050602	LC-Conf	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20050602	TC-Conf	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20050602	TC-E20	Tar Creek	06/02/05
OU5_SW_All_T	OU5_SW_TC_T	376181_20050607	07185100	Tar Creek	06/07/05
OU5_SW_All_T	OU5_SW_TC_T	376182_20050607	07185095	Tar Creek	06/07/05
OU5_SW_All_T	OU5_SW_TC_T	376184_20050607	07185090	Tar Creek	06/07/05
OU5_SW_All_T	OU5_SW_TC_T	376187_20050608	07185088	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	376190_20050608	071850870	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	376191_20050608	071850825	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	376192_20050608	071850815	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 026_20050608	TCSW026	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 027_20050608	TCSW027	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 028_20050608	TCSW028	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 029_20050608	TCSW029	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 031_20050608	TCSW031	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 032_20050608	TCSW032	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 033_20050608	TCSW033	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 034_20050608	TCSW034	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW 037_20050608	TCSW037	Tar Creek	06/08/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-038_20050609	TCSW038	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-039_20050609	TCSW039	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-040_20050609	TCSW040	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-041_20050609	TCSW041	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-042_20050609	TCSW042	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-043_20050609	TCSW043	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-044_20050609	TCSW044	Tar Creek	06/09/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCSW-045_20050609	TCSW045	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-046_20050609	TCSW046	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-047_20050609	TCSW047	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-048_20050609	TCSW048	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-049_20050609	TCSW049	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-050_20050609	TCSW050	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-051_20050609	TCSW051	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-052_20050609	TCSW052	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-053_20050609	TCSW053	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-054_20050609	TCSW054	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-055_20050609	TCSW055	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-056_20050609	TCSW056	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-057_20050609	TCSW057	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-058_20050609	TCSW058	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-059_20050609	TCSW059	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-060_20050609	TCSW060	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-061_20050609	TCSW061	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-062_20050609	TCSW062	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-063_20050609	TCSW063	Tar Creek	06/09/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-064_20050610	TCSW064	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-065_20050610	TCSW065	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-066_20050610	TCSW066	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-067_20050610	TCSW067	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-068_20050610	TCSW068	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-069_20050610	TCSW069	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-070_20050610	TCSW070	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-071_20050610	TCSW071	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-072_20050610	TCSW072	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-073_20050610	TCSW073	Tar Creek	06/10/05
OU5_SW_All_T	OU5_SW_TC_T	376352_20050613	07185090	Tar Creek	06/13/05
OU5_SW_All_T	OU5_SW_TC_T	376353_20050613	07185095	Tar Creek	06/13/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCM061405SW	TCM	Tar Creek	06/14/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL061505SW	TCSL	Tar Creek	06/15/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW077_20050616	TCSW077	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW078_20050616	TCSW078	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW079_20050616	TCSW079	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW080_20050616	TCSW080	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW081_20050616	TCSW081	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW082_20050616	TCSW082	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW083_20050616	TCSW083	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW084_20050616	TCSW084	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW085_20050616	TCSW085	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW086_20050616	TCSW086	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW087_20050616	TCSW087	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW088_20050616	TCSW088	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW089_20050616	TCSW089	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW090_20050616	TCSW090	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW091_20050616	TCSW091	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW092_20050616	TCSW092	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW093_20050616	TCSW093	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW094_20050616	TCSW094	Tar Creek	06/16/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW095_20050621	TCSW095	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW096_20050621	TCSW096	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW097_20050621	TCSW097	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW098_20050621	TCSW098	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW099_20050621	TCSW099	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW100_20050621	TCSW100	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW101_20050621	TCSW101	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW102_20050621	TCSW102	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW103_20050621	TCSW103	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW104_20050621	TCSW104	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW105_20050621	TCSW105	Tar Creek	06/21/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCSW106_20050621	TCSW106	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW107_20050621	TCSW107	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW108_20050621	TCSW108	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW109_20050621	TCSW109	Tar Creek	06/21/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-110_20050622	TCSW110	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-111_20050622	TCSW111	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-112_20050622	TCSW112	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-113_20050622	TCSW113	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-114_20050622	TCSW114	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-115_20050622	TCSW115	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-117_20050622	TCSW117	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-118_20050622	TCSW118	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-119_20050622	TCSW119	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-121_20050622	TCSW121	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-120_20050622	TCSW120	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-122_20050622	TCSW122	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-123_20050622	TCSW123	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-124_20050622	TCSW124	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-126_20050622	TCSW126	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCSW-127_20050622	TCSW127	Tar Creek	06/22/05
OU5_SW_All_T	OU5_SW_TC_T	377757_20050629	07185090	Tar Creek	06/29/05
OU5_SW_All_T	OU5_SW_TC_T	377759_20050629	07185095	Tar Creek	06/29/05
OU5_SW_All_T	OU5_SW_TC_T	377760_20050629	07185100	Tar Creek	06/29/05
OU5_SW_All_T	OU5_SW_TC_T	377751_20050630	071850815	Tar Creek	06/30/05
OU5_SW_All_T	OU5_SW_TC_T	377753_20050630	071850825	Tar Creek	06/30/05
OU5_SW_All_T	OU5_SW_TC_T	377754_20050630	071850870	Tar Creek	06/30/05
OU5_SW_All_T	OU5_SW_TC_T	377756_20050630	07185088	Tar Creek	06/30/05
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20050705	Garrett	Tar Creek	07/05/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050706	TC-22	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050706	TC-R	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050706	UT-R	Tar Creek	07/06/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050706	TC-US69	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050706	MR-UTD	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050706	TC-D	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050706	MR-UTU	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20050706	LC-Conf	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050706	M-SA	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20050706	TC-Conf	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050706	MR-SB (original)	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20050706	TC-E20	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20050706	TC-US166	Tar Creek	07/06/05
OU5_SW_All_T	OU5_SW_TC_T	TCM071305SW	TCM	Tar Creek	07/13/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL071305SW	TCSL	Tar Creek	07/13/05
OU5_SW_All_T	OU5_SW_TC_T	1266_20050715	07185090	Tar Creek	07/15/05
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050715	071850870	Tar Creek	07/15/05
OU5_SW_All_T	OU5_SW_TC_T	071850840_WS_20050715	071850840	Tar Creek	07/15/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050803	TC-22	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050803	TC-R	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050803	UT-R	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050803	TC-US69	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050803	TC-D	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050803	MR-UTD	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20050803	TC-Conf	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050803	MR-UTU	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050803	M-SA	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050803	MR-SB (original)	Tar Creek	08/03/05
OU5_SW_All_T	OU5_SW_TC_T	071850875_WS_20050816	071850875	Tar Creek	08/16/05
OU5_SW_All_T	OU5_SW_TC_T	071850818_WS_20050816	071850818	Tar Creek	08/16/05
OU5_SW_All_T	OU5_SW_TC_T	071850825_WS_20050816	071850825	Tar Creek	08/16/05
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050816	071850870	Tar Creek	08/16/05
OU5_SW_All_T	OU5_SW_TC_T	071850875_WS_20050818	071850875	Tar Creek	08/18/05
OU5_SW_All_T	OU5_SW_TC_T	071850825_WS_20050818	071850825	Tar Creek	08/18/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050818	071850870	Tar Creek	08/18/05
OU5_SW_All_T	OU5_SW_TC_T	071850875_WS_20050820	071850875	Tar Creek	08/20/05
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050820	071850870	Tar Creek	08/20/05
OU5_SW_All_T	OU5_SW_TC_T	071850825_WS_20050820	071850825	Tar Creek	08/20/05
OU5_SW_All_T	OU5_SW_TC_T	071850875_WS_20050822	071850875	Tar Creek	08/22/05
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050822	071850870	Tar Creek	08/22/05
OU5_SW_All_T	OU5_SW_TC_T	071850825_WS_20050822	071850825	Tar Creek	08/22/05
OU5_SW_All_T	OU5_SW_TC_T	TCM082405SW	TCM	Tar Creek	08/24/05
OU5_SW_All_T	OU5_SW_TC_T	071850875_WS_20050824	071850875	Tar Creek	08/24/05
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050824	071850870	Tar Creek	08/24/05
OU5_SW_All_T	OU5_SW_TC_T	071850825_WS_20050824	071850825	Tar Creek	08/24/05
OU5_SW_All_T	OU5_SW_TC_T	071850875_WS_20050826	071850875	Tar Creek	08/26/05
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050826	071850870	Tar Creek	08/26/05
OU5_SW_All_T	OU5_SW_TC_T	071850825_WS_20050826	071850825	Tar Creek	08/26/05
OU5_SW_All_T	OU5_SW_TC_T	071850875_WS_20050829	071850875	Tar Creek	08/29/05
OU5_SW_All_T	OU5_SW_TC_T	071850870_WS_20050829	071850870	Tar Creek	08/29/05
OU5_SW_All_T	OU5_SW_TC_T	071850825_WS_20050829	071850825	Tar Creek	08/29/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20050909	TC-22	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20050909	TC-R	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20050909	UT-R	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20050909	TC-US69	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20050909	TC-D	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20050909	LC-Conf	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20050909	MR-UTD	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20050909	TC-Conf	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20050909	MR-UTU	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20050909	MR-SB (original)	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20050909	M-SA	Tar Creek	09/09/05
OU5_SW_All_T	OU5_SW_TC_T	1267_20050915	07185090	Tar Creek	09/15/05
OU5_SW_All_T	OU5_SW_TC_T	1408_20050915	07185095	Tar Creek	09/15/05
OU5_SW_All_T	OU5_SW_TC_T	TCM092005SW	TCM	Tar Creek	09/20/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCSL092005SW	TCSL	Tar Creek	09/20/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20051007	TC-22	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20051007	TC-R	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20051007	UT-R	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20051007	MR-UTD	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20051007	TC-US69	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20051007	TC-D	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20051007	MR-UTU	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20051007	LC-Conf	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20051007	TC-Conf	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20051007	MR-SB (original)	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20051007	M-SA	Tar Creek	10/07/05
OU5_SW_All_T	OU5_SW_TC_T	TCM101205SW	TCM	Tar Creek	10/12/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL101205SW	TCSL	Tar Creek	10/12/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20051104	TC-22	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20051104	UT-R	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20051104	TC-US69	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20051104	TC-D	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20051104	MR-UTD	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20051104	LC-Conf	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20051104	MR-UTU	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20051104	TC-Conf	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20051104	M-SA	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20051104	MR-SB (original)	Tar Creek	11/04/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL113005SW	TCSL	Tar Creek	11/30/05
OU5_SW_All_T	OU5_SW_TC_T	TCM113005SW	TCM	Tar Creek	11/30/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20051202	TC-22	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20051202	TC-R	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20051202	UT-R	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20051202	TC-US69	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20051202	TC-D	Tar Creek	12/02/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20051202	MR-UTD	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20051202	LC-Conf	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20051202	M-SA	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20051202	TC-Conf	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20051202	MR-SB (original)	Tar Creek	12/02/05
OU5_SW_All_T	OU5_SW_TC_T	TCM122705SW	TCM	Tar Creek	12/27/05
OU5_SW_All_T	OU5_SW_TC_T	TCSL122705SW	TCSL	Tar Creek	12/27/05
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060110	TC-22	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060110	TC-R	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060110	UT-R	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060110	TC-US69	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060110	TC-D	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060110	MR-UTD	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20060110	LC-Conf	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060110	TC-Conf	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060110	MR-UTU	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20060110	M-SA	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060110	MR-SB (original)	Tar Creek	01/10/06
OU5_SW_All_T	OU5_SW_TC_T	TCM011106SW	TCM	Tar Creek	01/11/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL011106SW	TCSL	Tar Creek	01/11/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060203	TC-22	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060203	TC-R	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060203	UT-R	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060203	TC-US69	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060203	MR-UTD	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060203	MR-UTU	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060203	TC-D	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20060203	M-SA	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060203	MR-SB (original)	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20060203	LC-Conf	Tar Creek	02/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060203	TC-Conf	Tar Creek	02/03/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCM021306SW	TCM	Tar Creek	02/13/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL021306SW	TCSL	Tar Creek	02/13/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060303	TC-22	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060303	TC-R	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060303	UT-R	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060303	MR-UTD	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060303	TC-US69	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060303	MR-UTU	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060303	MR-SB (original)	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060303	TC-D	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20060303	LC-Conf	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060303	TC-Conf	Tar Creek	03/03/06
OU5_SW_All_T	OU5_SW_TC_T	TCM031506SW	TCM	Tar Creek	03/15/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL031506SW	TCSL	Tar Creek	03/15/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060406	TC-22	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060406	TC-R	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060406	UT-R	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060406	MR-UTD	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060406	TC-US69	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060406	TC-D	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060406	MR-UTU	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20060406	LC-Conf	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060406	TC-Conf	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060406	MR-SB (original)	Tar Creek	04/06/06
OU5_SW_All_T	OU5_SW_TC_T	TCM041206SW	TCM	Tar Creek	04/12/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL041206SW	TCSL	Tar Creek	04/12/06
OU5_SW_All_T	OU5_SW_TC_T	1268_20060425	07185090	Tar Creek	04/25/06
OU5_SW_All_T	OU5_SW_TC_T	1409_20060425	07185095	Tar Creek	04/25/06
OU5_SW_All_T	OU5_SW_TC_T	1279_20060429	07185090	Tar Creek	04/29/06
OU5_SW_All_T	OU5_SW_TC_T	1410_20060429	07185095	Tar Creek	04/29/06
OU5_SW_All_T	OU5_SW_TC_T	1280_20060430	07185090	Tar Creek	04/30/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	1002_20060502	TAR-BK02	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1003_20060502	TAR-010	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1004_20060502	TAR-BK01	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1081_20060502	TAR-001	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1082_20060502	TAR-002	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1086_20060502	TAR-005	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1087_20060502	TAR-006	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1088_20060502	TAR-007	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1092_20060502	TAR-101	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1096_20060502	TAR-201	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1098_20060502	TAR-302	Tar Creek	05/02/06
OU5_SW_All_T	OU5_SW_TC_T	1089_20060503	TAR-008	Tar Creek	05/03/06
OU5_SW_All_T	OU5_SW_TC_T	1090_20060503	TAR-009	Tar Creek	05/03/06
OU5_SW_All_T	OU5_SW_TC_T	1093_20060503	TAR-102	Tar Creek	05/03/06
OU5_SW_All_T	OU5_SW_TC_T	1095_20060503	TAR-103	Tar Creek	05/03/06
OU5_SW_All_T	OU5_SW_TC_T	1084_20060504	TAR-003	Tar Creek	05/04/06
OU5_SW_All_T	OU5_SW_TC_T	1085_20060504	TAR-004	Tar Creek	05/04/06
OU5_SW_All_T	OU5_SW_TC_T	1097_20060504	TAR-301	Tar Creek	05/04/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060505	TC-22	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060505	TC-R	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060505	UT-R	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060505	TC-US69	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060505	TC-D	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060505	MR-UTD	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20060505	LC-Conf	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060505	TC-Conf	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060505	MR-UTU	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20060505	TC-E20	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20060505	M-SA	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20060505	TC-US166	Tar Creek	05/05/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060505	MR-SB (original)	Tar Creek	05/05/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCM051606SW	TCM	Tar Creek	05/16/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL051606SW	TCSL	Tar Creek	05/16/06
OU5_SW_All_T	OU5_SW_TC_T	W455-W466_20060602	HSPH-TC-33	Tar Creek	06/02/06
OU5_SW_All_T	OU5_SW_TC_T	W493-W496_20060602	HSPH-TC-32	Tar Creek	06/02/06
OU5_SW_All_T	OU5_SW_TC_T	W497-W508_20060602	HSPH-TC-31	Tar Creek	06/02/06
OU5_SW_All_T	OU5_SW_TC_T	W529-W540_20060603	HSPH-TC-30	Tar Creek	06/03/06
OU5_SW_All_T	OU5_SW_TC_T	W550-W561_20060603	HSPH-TC-29	Tar Creek	06/03/06
OU5_SW_All_T	OU5_SW_TC_T	W568-W579_20060603	HSPH-TC-28	Tar Creek	06/03/06
OU5_SW_All_T	OU5_SW_TC_T	W591-W602_20060603	HSPH-TC-27	Tar Creek	06/03/06
OU5_SW_All_T	OU5_SW_TC_T	W605-W608_20060603	HSPH-LC-05	Tar Creek	06/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060607	TC-22	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060607	TC-R	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060607	UT-R	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060607	TC-US69	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060607	MR-UTD	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060607	TC-D	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20060607	LC-Conf	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060607	TC-Conf	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060607	MR-UTU	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20060607	M-SA	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20060607	TC-E20	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060607	MR-SB (original)	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20060607	TC-US166	Tar Creek	06/07/06
OU5_SW_All_T	OU5_SW_TC_T	TCM061306SW	TCM	Tar Creek	06/13/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL061306SW	TCSL	Tar Creek	06/13/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060707	TC-22	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060707	TC-R	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060707	UT-R	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060707	TC-US69	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060707	MR-UTD	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060707	TC-D	Tar Creek	07/07/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060707	MR-UTU	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20060707	LC-Conf	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20060707	M-SA	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060707	TC-Conf	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20060707	TC-E20	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060707	MR-SB (original)	Tar Creek	07/07/06
OU5_SW_All_T	OU5_SW_TC_T	TCM072006SW	TCM	Tar Creek	07/20/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL072006SW	TCSL	Tar Creek	07/20/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060802	TC-22	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060802	TC-R	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060802	UT-R	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060802	TC-US69	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060802	MR-UTD	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060802	TC-D	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060802	MR-UTU	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060802	TC-Conf	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20060802	M-SA	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060802	MR-SB (original)	Tar Creek	08/02/06
OU5_SW_All_T	OU5_SW_TC_T	TCM081706SW	TCM	Tar Creek	08/17/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20060908	TC-22	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20060908	TC-R	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20060908	UT-R	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20060908	TC-US69	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20060908	TC-D	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20060908	TC-Conf	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20060908	MR-UTD	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20060908	MR-UTU	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20060908	M-SA	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20060908	MR-SB (original)	Tar Creek	09/08/06
OU5_SW_All_T	OU5_SW_TC_T	TCM091206SW	TCM	Tar Creek	09/12/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20061006	TC-22	Tar Creek	10/06/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20061006	TC-R	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20061006	UT-R	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20061006	TC-US69	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20061006	MR-UTD	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20061006	TC-D	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20061006	MR-UTU	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20061006	TC-Conf	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20061006	M-SA	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20061006	MR-SB (original)	Tar Creek	10/06/06
OU5_SW_All_T	OU5_SW_TC_T	TCM101806SW	TCM	Tar Creek	10/18/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL101806SW	TCSL	Tar Creek	10/18/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20061103	TC-22	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20061103	TC-R	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20061103	UT-R	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20061103	TC-US69	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20061103	MR-UTD	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20061103	TC-D	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20061103	MR-UTU	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20061103	TC-Conf	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20061103	MR-SB (original)	Tar Creek	11/03/06
OU5_SW_All_T	OU5_SW_TC_T	106TC110806-S	106TC	Tar Creek	11/08/06
OU5_SW_All_T	OU5_SW_TC_T	TCM111606SW	TCM	Tar Creek	11/16/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL111606SW	TCSL	Tar Creek	11/16/06
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20061204	TC-22	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20061204	TC-R	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20061204	UT-R	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20061204	TC-US69	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20061204	TC-D	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20061204	MR-UTD	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20061204	LC-Conf	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20061204	MR-UTU	Tar Creek	12/04/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20061204	TC-Conf	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20061204	MR-SB (original)	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20061204	TC-E20	Tar Creek	12/04/06
OU5_SW_All_T	OU5_SW_TC_T	TCM121406SW	TCM	Tar Creek	12/14/06
OU5_SW_All_T	OU5_SW_TC_T	TCSL121406SW	TCSL	Tar Creek	12/14/06
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20070104	Garrett	Tar Creek	01/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070105	TC-22	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070105	M-SA	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070105	TC-R	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070105	UT-R	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070105	TC-US69	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070105	TC-D	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070105	MR-UTD	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070105	LC-Conf	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070105	TC-Conf	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070105	MR-UTU	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20070105	TC-E20	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20070105	MR-SB (original)	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20070105	TC-US166	Tar Creek	01/05/07
OU5_SW_All_T	OU5_SW_TC_T	106TC010807-S	106TC	Tar Creek	01/08/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070202	TC-22	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070202	TC-R	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070202	UT-R	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070202	TC-US69	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070202	TC-D	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070202	MR-UTD	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070202	LC-Conf	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070202	MR-UTU	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070202	TC-Conf	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20070202	MR-SB (original)	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20070202	TC-E20	Tar Creek	02/02/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070202	M-SA	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20070202	TC-US166	Tar Creek	02/02/07
OU5_SW_All_T	OU5_SW_TC_T	TCM022107SW	TCM	Tar Creek	02/21/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL022107SW	TCSL	Tar Creek	02/21/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070302	TC-22	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070302	TC-R	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070302	UT-R	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070302	TC-US69	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070302	TC-D	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070302	LC-Conf	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070302	TC-Conf	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20070302	TC-E20	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070302	MR-UTD	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20070302	TC-US166	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070302	MR-UTU	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070302	M-SA	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB (ORIGINAL)_20070302	MR-SB (original)	Tar Creek	03/02/07
OU5_SW_All_T	OU5_SW_TC_T	106TC030507-S	106TC	Tar Creek	03/05/07
OU5_SW_All_T	OU5_SW_TC_T	TCM032107SW	TCM	Tar Creek	03/21/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL032107SW	TCSL	Tar Creek	03/21/07
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20070405	Garrett	Tar Creek	04/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070406	TC-22	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20070406	MR-SB	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070406	TC-R	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070406	UT-R	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070406	M-SA	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070406	TC-US69	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070406	MR-UTD	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070406	TC-D	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070406	MR-UTU	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070406	LC-Conf	Tar Creek	04/06/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070406	TC-Conf	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20070406	TC-E20	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20070406	TC-US166	Tar Creek	04/06/07
OU5_SW_All_T	OU5_SW_TC_T	TCM041907SW	TCM	Tar Creek	04/19/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL041907SW	TCSL	Tar Creek	04/19/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070504	TC-22	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070504	TC-R	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070504	UT-R	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070504	TC-US69	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070504	TC-D	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070504	LC-Conf	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070504	TC-Conf	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20070504	TC-E20	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070504	MR-UTD	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20070504	TC-US166	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070504	MR-UTU	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070504	M-SA	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20070504	MR-SB	Tar Creek	05/04/07
OU5_SW_All_T	OU5_SW_TC_T	TCM053107SW	TCM	Tar Creek	05/31/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL053107SW	TCSL	Tar Creek	05/31/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070601	TC-22	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070601	TC-R	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070601	UT-R	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070601	TC-US69	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070601	TC-D	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070601	LC-Conf	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070601	TC-Conf	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070601	MR-UTD	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20070601	TC-E20	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070601	MR-UTU	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070601	M-SA	Tar Creek	06/01/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20070601	TC-US166	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20070601	MR-SB	Tar Creek	06/01/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL062707SW	TCSL	Tar Creek	06/27/07
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20070705	Garrett	Tar Creek	07/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070706	TC-22	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070706	TC-R	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070706	UT-R	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070706	TC-US69	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070706	TC-D	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070706	LC-Conf	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070706	TC-Conf	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20070706	TC-E20	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20070706	TC-US166	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070706	MR-UTD	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070706	MR-UTU	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070706	M-SA	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20070706	MR-SB	Tar Creek	07/06/07
OU5_SW_All_T	OU5_SW_TC_T	TCM071907SW	TCM	Tar Creek	07/19/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL071907SW	TCSL	Tar Creek	07/19/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070803	TC-22	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070803	TC-R	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070803	TC-Conf	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070803	UT-R	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070803	TC-US69	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070803	TC-D	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070803	LC-Conf	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070803	MR-UTD	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070803	M-SA	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20070803	MR-SB	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070803	MR-UTU	Tar Creek	08/03/07
OU5_SW_All_T	OU5_SW_TC_T	106TC080607-S	106TC	Tar Creek	08/06/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCM081607SW	TCM	Tar Creek	08/16/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL081607SW	TCSL	Tar Creek	08/16/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20070907	TC-22	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20070907	TC-R	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20070907	UT-R	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20070907	TC-US69	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20070907	TC-D	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20070907	MR-UTD	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20070907	LC-Conf	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20070907	TC-Conf	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20070907	MR-UTU	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20070907	M-SA	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20070907	MR-SB	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20070907	UT-P	Tar Creek	09/07/07
OU5_SW_All_T	OU5_SW_TC_T	TCM092007SW	TCM	Tar Creek	09/20/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL092007SW	TCSL	Tar Creek	09/20/07
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20071004	Garrett	Tar Creek	10/04/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20071005	TC-22	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20071005	TC-R	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20071005	UT-R	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20071005	TC-US69	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20071005	TC-D	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20071005	MR-UTD	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20071005	LC-Conf	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20071005	TC-Conf	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20071005	MR-UTU	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20071005	TC-E20	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20071005	M-SA	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20071005	MR-SB	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20071005	UT-P	Tar Creek	10/05/07
OU5_SW_All_T	OU5_SW_TC_T	106TC100907-S	106TC	Tar Creek	10/09/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCM102407SW	TCM	Tar Creek	10/24/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL102407SW	TCSL	Tar Creek	10/24/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20071102	TC-22	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20071102	TC-R	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20071102	UT-R	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20071102	TC-US69	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20071102	TC-D	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20071102	MR-UTD	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20071102	LC-Conf	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20071102	MR-UTU	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20071102	TC-Conf	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20071102	M-SA	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20071102	UT-P	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20071102	MR-SB	Tar Creek	11/02/07
OU5_SW_All_T	OU5_SW_TC_T	TCM112607SW	TCM	Tar Creek	11/26/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL112607SW	TCSL	Tar Creek	11/26/07
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20071207	TC-22	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20071207	TC-R	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20071207	UT-R	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20071207	TC-US69	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20071207	TC-D	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20071207	MR-UTD	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20071207	LC-Conf	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20071207	TC-Conf	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20071207	MR-UTU	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20071207	M-SA	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20071207	TC-E20	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20071207	MR-SB	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20071207	UT-P	Tar Creek	12/07/07
OU5_SW_All_T	OU5_SW_TC_T	TCM121907SW	TCM	Tar Creek	12/19/07
OU5_SW_All_T	OU5_SW_TC_T	TCSL121907SW	TCSL	Tar Creek	12/19/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	106TC010708-S	106TC	Tar Creek	01/07/08
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20080107	Garrett	Tar Creek	01/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080108	TC-22	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080108	TC-R	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080108	UT-R	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080108	TC-US69	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080108	TC-D	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080108	LC-Conf	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080108	TC-Conf	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080108	MR-UTD	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080108	MR-UTU	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080108	TC-E20	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080108	M-SA	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080108	MR-SB	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20080108	TC-US166	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080108	UT-P	Tar Creek	01/08/08
OU5_SW_All_T	OU5_SW_TC_T	TCM010908SW	TCM	Tar Creek	01/09/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL010908SW	TCSL	Tar Creek	01/09/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080201	TC-22	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080201	TC-R	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080201	UT-R	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080201	TC-US69	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080201	TC-D	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080201	MR-UTD	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080201	LC-Conf	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080201	TC-Conf	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080201	MR-UTU	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080201	TC-E20	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080201	M-SA	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080201	MR-SB	Tar Creek	02/01/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080201	UT-P	Tar Creek	02/01/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCM022009SW	TCM	Tar Creek	02/20/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL022008SW	TCSL	Tar Creek	02/20/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080307	TC-22	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080307	TC-R	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080307	UT-R	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080307	TC-US69	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080307	TC-D	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080307	LC-Conf	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080307	MR-UTD	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080307	TC-Conf	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080307	MR-UTU	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080307	TC-E20	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080307	M-SA	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080307	MR-SB	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20080307	TC-US166	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080307	UT-P	Tar Creek	03/07/08
OU5_SW_All_T	OU5_SW_TC_T	106TC031008-S	106TC	Tar Creek	03/10/08
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20080403	Garrett	Tar Creek	04/03/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080404	TC-22	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080404	TC-R	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080404	UT-R	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080404	TC-US69	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080404	TC-D	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080404	LC-Conf	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080404	TC-Conf	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080404	MR-UTD	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080404	TC-E20	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080404	MR-UTU	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20080404	TC-US166	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080404	M-SA	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080404	MR-SB	Tar Creek	04/04/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080404	UT-P	Tar Creek	04/04/08
OU5_SW_All_T	OU5_SW_TC_T	TCM041508SW	TCM	Tar Creek	04/15/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL041508SW	TCSL	Tar Creek	04/15/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080509	TC-R	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080509	UT-R	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080509	TC-US69	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080509	TC-D	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080509	LC-Conf	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080509	TC-Conf	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080509	MR-UTD	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080509	MR-UTU	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080509	M-SA	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080509	TC-E20	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080509	MR-SB	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080509	UT-P	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20080509	TC-US166	Tar Creek	05/09/08
OU5_SW_All_T	OU5_SW_TC_T	TCM051408SW	TCM	Tar Creek	05/14/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL051408SW	TCSL	Tar Creek	05/14/08
OU5_SW_All_T	OU5_SW_TC_T	TCM060508SW	TCM	Tar Creek	06/05/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL060508SW	TCSL	Tar Creek	06/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080606	TC-22	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080606	TC-R	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080606	UT-R	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080606	TC-US69	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080606	TC-D	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080606	LC-Conf	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080606	TC-Conf	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080606	MR-UTD	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080606	TC-E20	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080606	MR-UTU	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20080606	TC-US166	Tar Creek	06/06/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080606	M-SA	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080606	MR-SB	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080606	UT-P	Tar Creek	06/06/08
OU5_SW_All_T	OU5_SW_TC_T	GARRETT_20080709	Garrett	Tar Creek	07/09/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080710	TC-22	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080710	TC-R	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080710	UT-R	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080710	TC-US69	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080710	TC-D	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080710	LC-Conf	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080710	TC-Conf	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080710	MR-UTD	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080710	TC-E20	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080710	MR-UTU	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20080710	TC-US166	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080710	M-SA	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080710	MR-SB	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080710	UT-P	Tar Creek	07/10/08
OU5_SW_All_T	OU5_SW_TC_T	TCM071608SW	TCM	Tar Creek	07/16/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL071608SW	TCSL	Tar Creek	07/16/08
OU5_SW_All_T	OU5_SW_TC_T	106TC071608-S	106TC	Tar Creek	07/16/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080808	TC-22	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080808	TC-R	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080808	UT-R	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080808	TC-US69	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080808	TC-D	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080808	LC-Conf	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080808	TC-Conf	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080808	TC-E20	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080808	MR-UTD	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080808	UT-P	Tar Creek	08/08/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080808	MR-SB	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080808	MR-UTU	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080808	M-SA	Tar Creek	08/08/08
OU5_SW_All_T	OU5_SW_TC_T	TCM082108SW	TCM	Tar Creek	08/21/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL082108SW	TCSL	Tar Creek	08/21/08
OU5_SW_All_T	OU5_SW_TC_T	TC-22_20080905	TC-22	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20080905	TC-R	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20080905	MR-SB	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20080905	M-SA	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20080905	UT-R	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20080905	MR-UTD	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20080905	MR-UTU	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20080905	TC-US69	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20080905	UT-P	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-D_20080905	TC-D	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	LC-CONF_20080905	LC-Conf	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-CONF_20080905	TC-Conf	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-E20_20080905	TC-E20	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US166_20080905	TC-US166	Tar Creek	09/05/08
OU5_SW_All_T	OU5_SW_TC_T	106TC090808-S	106TC	Tar Creek	09/08/08
OU5_SW_All_T	OU5_SW_TC_T	TCM092408SW	TCM	Tar Creek	09/24/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL092408SW	TCSL	Tar Creek	09/24/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20081003	MR-SB	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20081003	TC-R	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20081003	UT-R	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20081003	MR-UTD	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20081003	MR-UTU	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20081003	M-SA	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20081003	UT-P	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20081003	TC-US69	Tar Creek	10/03/08
OU5_SW_All_T	OU5_SW_TC_T	106TC100708-S	106TC	Tar Creek	10/07/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TCM102008SW	TCM	Tar Creek	10/20/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL102008SW	TCSL	Tar Creek	10/20/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20081107	TC-R	Tar Creek	11/07/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20081107	M-SA	Tar Creek	11/07/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20081107	UT-R	Tar Creek	11/07/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20081107	TC-US69	Tar Creek	11/07/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20081107	MR-UTD	Tar Creek	11/07/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20081107	MR-UTU	Tar Creek	11/07/08
OU5_SW_All_T	OU5_SW_TC_T	TCM111708SW	TCM	Tar Creek	11/17/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL111708SW	TCSL	Tar Creek	11/17/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20081205	TC-R	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20081205	M-SA	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20081205	UT-R	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20081205	MR-SB	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20081205	TC-US69	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20081205	MR-UTD	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20081205	MR-UTU	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20081205	UT-P	Tar Creek	12/05/08
OU5_SW_All_T	OU5_SW_TC_T	106TC120808-S	106TC	Tar Creek	12/08/08
OU5_SW_All_T	OU5_SW_TC_T	TCM121908SW	TCM	Tar Creek	12/19/08
OU5_SW_All_T	OU5_SW_TC_T	TCSL121908SW	TCSL	Tar Creek	12/19/08
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090106	TC-R	Tar Creek	01/06/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090106	UT-R	Tar Creek	01/06/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090106	MR-UTD	Tar Creek	01/06/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090106	MR-UTU	Tar Creek	01/06/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090106	UT-P	Tar Creek	01/06/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090106	TC-US69	Tar Creek	01/06/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090107	MR-SB	Tar Creek	01/07/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090107	M-SA	Tar Creek	01/07/09
OU5_SW_All_T	OU5_SW_TC_T	TCM012209SW	TCM	Tar Creek	01/22/09
OU5_SW_All_T	OU5_SW_TC_T	TCSL012209SW	TCSL	Tar Creek	01/22/09

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090205	TC-R	Tar Creek	02/05/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090205	UT-R	Tar Creek	02/05/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090205	MR-UTD	Tar Creek	02/05/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090205	MR-UTU	Tar Creek	02/05/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090205	UT-P	Tar Creek	02/05/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090205	TC-US69	Tar Creek	02/05/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090205	M-SA	Tar Creek	02/05/09
OU5_SW_All_T	OU5_SW_TC_T	106TC021709-S	106TC	Tar Creek	02/17/09
OU5_SW_All_T	OU5_SW_TC_T	TCM022609SW	TCM	Tar Creek	02/26/09
OU5_SW_All_T	OU5_SW_TC_T	TCSL022609SW	TCSL	Tar Creek	02/26/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090305	TC-R	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090305	UT-R	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090305	MR-UTD	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090305	MR-UTU	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090305	TC-US69	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZF4	RVR0001-0025SW	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZF6	RVR0001-0026SW	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZD0	RVR0001-0014SW	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090305	UT-P	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZC8	RVR0001-0013SW	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090305	MR-SB	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090305	M-SA	Tar Creek	03/05/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZC6	RVR0001-0012SW	Tar Creek	03/06/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZF2	RVR0001-0024SW	Tar Creek	03/06/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZC4	RVR0001-0011SW	Tar Creek	03/06/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZF0	RVR0001-0023SW	Tar Creek	03/06/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZE8	RVR0001-0022SW	Tar Creek	03/06/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZE6	RVR0001-0021SW	Tar Creek	03/07/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZD4	RVR0001-0016SW	Tar Creek	03/07/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZE3	RVR0001-0020SW	Tar Creek	03/07/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZD2	RVR0001-0015SW	Tar Creek	03/07/09

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MF2ZK8	RVR0002-0014SW	Tar Creek	03/07/09
OU5_SW_All_T	OU5_SW_TC_T	MF2ZE0	RVR0001-0019SW	Tar Creek	03/07/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0018SW	RVR0001-0018SW	Tar Creek	03/17/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0017SW	RVR0001-0017SW	Tar Creek	03/17/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0010SW	RVR0001-0010SW	Tar Creek	03/17/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0005SW	RVR0001-0005SW	Tar Creek	03/17/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0006SW	RVR0001-0006SW	Tar Creek	03/17/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0027SW	RVR0001-0027SW	Tar Creek	03/18/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0007SW	RVR0001-0007SW	Tar Creek	03/18/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0028SW	RVR0001-0028SW	Tar Creek	03/18/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0008SW	RVR0001-0008SW	Tar Creek	03/18/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0013SW	RVR0002-0013SW	Tar Creek	03/19/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0012SW	RVR0002-0012SW	Tar Creek	03/19/09
OU5_SW_All_T	OU5_SW_TC_T	TCM031909SW	TCM	Tar Creek	03/19/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0009SW	RVR0001-0009SW	Tar Creek	03/20/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0011SW	RVR0002-0011SW	Tar Creek	03/20/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0010SW	RVR0002-0010SW	Tar Creek	03/20/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0001SW	RVR0001-0001SW	Tar Creek	03/20/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0009SW	RVR0002-0009SW	Tar Creek	03/25/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0004SW	RVR0001-0004SW	Tar Creek	03/25/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0003SW	RVR0001-0003SW	Tar Creek	03/25/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0008SW	RVR0002-0008SW	Tar Creek	03/25/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0007SW	RVR0002-0007SW	Tar Creek	03/26/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0001-0002SW	RVR0001-0002SW	Tar Creek	03/26/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0006SW	RVR0002-0006SW	Tar Creek	03/26/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0001SW	RVR0002-0001SW	Tar Creek	03/27/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0002SW	RVR0002-0002SW	Tar Creek	03/27/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0003SW	RVR0002-0003SW	Tar Creek	03/28/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0004SW	RVR0002-0004SW	Tar Creek	03/28/09
OU5_SW_All_T	OU5_SW_TC_T	RVR0002-0005SW	RVR0002-0005SW	Tar Creek	03/28/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090402	TC-R	Tar Creek	04/02/09

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090402	MR-UTD	Tar Creek	04/02/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090402	UT-R	Tar Creek	04/02/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090402	MR-UTU	Tar Creek	04/02/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090402	TC-US69	Tar Creek	04/02/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090402	UT-P	Tar Creek	04/02/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090402	MR-SB	Tar Creek	04/02/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090402	M-SA	Tar Creek	04/02/09
OU5_SW_All_T	OU5_SW_TC_T	106TC042109-S	106TC	Tar Creek	04/21/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090507	TC-R	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090507	UT-R	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090507	MR-UTD	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090507	MR-UTU	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090507	UT-P	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090507	TC-US69	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090507	MR-SB	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090507	M-SA	Tar Creek	05/07/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090609	TC-R	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090609	UT-R	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090609	MR-UTD	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090609	MR-UTU	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090609	UT-P	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090609	TC-US69	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090609	MR-SB	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090609	M-SA	Tar Creek	06/09/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090709	TC-R	Tar Creek	07/09/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090709	UT-R	Tar Creek	07/09/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090709	MR-UTD	Tar Creek	07/09/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090709	MR-UTU	Tar Creek	07/09/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090709	UT-P	Tar Creek	07/09/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090709	TC-US69	Tar Creek	07/09/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090709	MR-SB	Tar Creek	07/09/09

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090709	M-SA	Tar Creek	07/09/09
OU5_SW_All_T	OU5_SW_TC_T	106TC071309-S	106TC	Tar Creek	07/13/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090804	TC-R	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090804	UT-R	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090804	MR-UTU	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090804	MR-UTD	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090804	TC-US69	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090804	UT-P	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090804	MR-SB	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090804	M-SA	Tar Creek	08/04/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20090903	TC-R	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20090903	UT-R	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20090903	MR-UTD	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20090903	MR-UTU	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20090903	TC-US69	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20090903	UT-P	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20090903	MR-SB	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20090903	M-SA	Tar Creek	09/03/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20091001	TC-R	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20091001	UT-R	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20091001	MR-UTD	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20091001	MR-UTU	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20091001	UT-P	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20091001	TC-US69	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20091001	MR-SB	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20091001	M-SA	Tar Creek	10/01/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20091105	TC-R	Tar Creek	11/05/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20091105	MR-UTD	Tar Creek	11/05/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20091105	MR-UTU	Tar Creek	11/05/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20091105	UT-P	Tar Creek	11/05/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20091105	TC-US69	Tar Creek	11/05/09

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20091106	MR-SB	Tar Creek	11/06/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20091106	M-SA	Tar Creek	11/06/09
OU5_SW_All_T	OU5_SW_TC_T	106TC110909-S	106TC	Tar Creek	11/09/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20091203	TC-R	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20091203	UT-R	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20091203	MR-UTD	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20091203	MR-UTU	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20091203	TC-US69	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20091203	UT-P	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20091203	MR-SB	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20091203	M-SA	Tar Creek	12/03/09
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100111	TC-R	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100111	UT-R	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100111	MR-UTU	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20100111	MR-UTD	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100111	UT-P	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100111	TC-US69	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100111	MR-SB	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100111	M-SA	Tar Creek	01/11/10
OU5_SW_All_T	OU5_SW_TC_T	TCM012510	TCM	Tar Creek	01/25/10
OU5_SW_All_T	OU5_SW_TC_T	TCSL012510	TCSL	Tar Creek	01/25/10
OU5_SW_All_T	OU5_SW_TC_T	106TC012510-S	106TC	Tar Creek	01/25/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100204	TC-R	Tar Creek	02/04/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100204	UT-R	Tar Creek	02/04/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100204	MR-UTU	Tar Creek	02/04/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100204	TC-US69	Tar Creek	02/04/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100204	UT-P	Tar Creek	02/04/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100204	MR-SB	Tar Creek	02/04/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100204	M-SA	Tar Creek	02/04/10
OU5_SW_All_T	OU5_SW_TC_T	TCM021810	TCM	Tar Creek	02/18/10
OU5_SW_All_T	OU5_SW_TC_T	TCSL021810	TCSL	Tar Creek	02/18/10

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20100304	MR-UTD	Tar Creek	03/04/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100304	M-SA	Tar Creek	03/04/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100304	MR-UTU	Tar Creek	03/04/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100305	TC-R	Tar Creek	03/05/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100305	UT-R	Tar Creek	03/05/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100305	MR-SB	Tar Creek	03/05/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100305	TC-US69	Tar Creek	03/05/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100305	UT-P	Tar Creek	03/05/10
OU5_SW_All_T	OU5_SW_TC_T	TCM031810	TCM	Tar Creek	03/18/10
OU5_SW_All_T	OU5_SW_TC_T	TCSL031810	TCSL	Tar Creek	03/18/10
OU5_SW_All_T	OU5_SW_TC_T	106TC033110-S	106TC	Tar Creek	03/31/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100401	MR-SB	Tar Creek	04/01/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100401	M-SA	Tar Creek	04/01/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100402	TC-R	Tar Creek	04/02/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100402	UT-R	Tar Creek	04/02/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20100402	MR-UTD	Tar Creek	04/02/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100402	MR-UTU	Tar Creek	04/02/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100402	UT-P	Tar Creek	04/02/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100402	TC-US69	Tar Creek	04/02/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100506	MR-SB	Tar Creek	05/06/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100506	M-SA	Tar Creek	05/06/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100507	TC-R	Tar Creek	05/07/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100507	UT-R	Tar Creek	05/07/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20100507	MR-UTD	Tar Creek	05/07/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100507	MR-UTU	Tar Creek	05/07/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100507	TC-US69	Tar Creek	05/07/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100507	UT-P	Tar Creek	05/07/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100602	TC-R	Tar Creek	06/02/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100602	UT-R	Tar Creek	06/02/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20100602	MR-UTD	Tar Creek	06/02/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100602	MR-UTU	Tar Creek	06/02/10

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100602	UT-P	Tar Creek	06/02/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100602	TC-US69	Tar Creek	06/02/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100603	MR-SB	Tar Creek	06/03/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100603	M-SA	Tar Creek	06/03/10
OU5_SW_All_T	OU5_SW_TC_T	106TC062310-S	106TC	Tar Creek	06/23/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100701	TC-R	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100701	UT-R	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20100701	MR-UTD	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100701	MR-UTU	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100701	TC-US69	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100701	UT-P	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100701	MR-SB	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100701	M-SA	Tar Creek	07/01/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20100804	TC-R	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20100804	UT-R	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20100804	MR-UTD	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20100804	MR-UTU	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20100804	UT-P	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20100804	TC-US69	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20100804	MR-SB	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20100804	M-SA	Tar Creek	08/04/10
OU5_SW_All_T	OU5_SW_TC_T	106TC082310-S	106TC	Tar Creek	08/23/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20101007	TC-R	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20101007	UT-R	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20101007	MR-UTD	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20101007	MR-UTU	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20101007	UT-P	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20101007	TC-US69	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20101007	MR-SB	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20101007	M-SA	Tar Creek	10/07/10
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20110113	TC-R	Tar Creek	01/13/11

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20110113	UT-R	Tar Creek	01/13/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20110113	MR-UTU	Tar Creek	01/13/11
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20110113	UT-P	Tar Creek	01/13/11
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20110113	MR-SB	Tar Creek	01/13/11
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20110113	TC-US69	Tar Creek	01/13/11
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20110113	M-SA	Tar Creek	01/13/11
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20110401	TC-R	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20110401	UT-R	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20110401	MR-UTD	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20110401	MR-UTU	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20110401	MR-SB	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20110401	UT-P	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20110401	TC-US69	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20110401	M-SA	Tar Creek	04/01/11
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20110707	TC-R	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20110707	UT-R	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20110707	MR-UTD	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20110707	MR-UTU	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20110707	UT-P	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20110707	TC-US69	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20110707	MR-SB	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20110707	M-SA	Tar Creek	07/07/11
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20111013	TC-R	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20111013	UT-R	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20111013	MR-UTD	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20111013	MR-UTU	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20111013	TC-US69	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20111013	UT-P	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20111013	MR-SB	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20111013	M-SA	Tar Creek	10/13/11
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20120110	MR-UTD	Tar Creek	01/10/12

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20120110	MR-UTU	Tar Creek	01/10/12
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20120110	UT-P	Tar Creek	01/10/12
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20120110	TC-US69	Tar Creek	01/10/12
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20120110	MR-SB	Tar Creek	01/10/12
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20120110	M-SA	Tar Creek	01/10/12
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20120406	MR-UTD	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20120406	TC-R	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20120406	UT-R	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20120406	MR-UTU	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20120406	UT-P	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20120406	TC-US69	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20120406	MR-SB	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20120406	M-SA	Tar Creek	04/06/12
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20121019	TC-R	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20121019	UT-R	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20121019	MR-UTD	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20121019	MR-UTU	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20121019	TC-US69	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20121019	UT-P	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20121019	MR-SB	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20121019	M-SA	Tar Creek	10/19/12
OU5_SW_All_T	OU5_SW_TC_T	106TC120412-S	106TC	Tar Creek	12/04/12
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20130111	MR-UTD	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20130111	MR-UTU	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20130111	TC-R	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20130111	TC-US69	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20130111	UT-P	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20130111	UT-R	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20130111	MR-SB	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20130111	M-SA	Tar Creek	01/11/13
OU5_SW_All_T	OU5_SW_TC_T	106TC042913-S	106TC	Tar Creek	04/29/13

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20130718	MR-SB	Tar Creek	07/18/13
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20130718	M-SA	Tar Creek	07/18/13
OU5_SW_All_T	OU5_SW_TC_T	106TC072513-S	106TC	Tar Creek	07/25/13
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20131003	MR-UTD	Tar Creek	10/03/13
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20131003	MR-UTU	Tar Creek	10/03/13
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20131003	MR-SB	Tar Creek	10/03/13
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20131003	M-SA	Tar Creek	10/03/13
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20131003	UT-P	Tar Creek	10/03/13
OU5_SW_All_T	OU5_SW_TC_T	TCM011314	TCM	Tar Creek	01/13/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL011314	TCSL	Tar Creek	01/13/14
OU5_SW_All_T	OU5_SW_TC_T	TCM021314	TCM	Tar Creek	02/13/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL021314	TCSL	Tar Creek	02/13/14
OU5_SW_All_T	OU5_SW_TC_T	106TC021914-S	106TC	Tar Creek	02/19/14
OU5_SW_All_T	OU5_SW_TC_T	106TC031114-S	106TC	Tar Creek	03/11/14
OU5_SW_All_T	OU5_SW_TC_T	TCM031314	TCM	Tar Creek	03/13/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL031314	TCSL	Tar Creek	03/13/14
OU5_SW_All_T	OU5_SW_TC_T	TCM040914	TCM	Tar Creek	04/09/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL040914	TCSL	Tar Creek	04/09/14
OU5_SW_All_T	OU5_SW_TC_T	TCM051314	TCM	Tar Creek	05/13/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL051314	TCSL	Tar Creek	05/13/14
OU5_SW_All_T	OU5_SW_TC_T	TCM061614	TCM	Tar Creek	06/16/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL061614	TCSL	Tar Creek	06/16/14
OU5_SW_All_T	OU5_SW_TC_T	106TC061714-S	106TC	Tar Creek	06/17/14
OU5_SW_All_T	OU5_SW_TC_T	TCM071414	TCM	Tar Creek	07/14/14
OU5_SW_All_T	OU5_SW_TC_T	TCM081314	TCM	Tar Creek	08/13/14
OU5_SW_All_T	OU5_SW_TC_T	106TC082014-S	106TC	Tar Creek	08/20/14
OU5_SW_All_T	OU5_SW_TC_T	TCM091514	TCM	Tar Creek	09/15/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL091514	TCSL	Tar Creek	09/15/14
OU5_SW_All_T	OU5_SW_TC_T	TCM101614	TCM	Tar Creek	10/16/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL101614	TCSL	Tar Creek	10/16/14
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20141017	TC-R	Tar Creek	10/17/14

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20141017	UT-R	Tar Creek	10/17/14
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20141017	UT-P	Tar Creek	10/17/14
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20141017	MR-SB	Tar Creek	10/17/14
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20141017	M-SA	Tar Creek	10/17/14
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20141017	MR-UTD	Tar Creek	10/17/14
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20141017	MR-UTU	Tar Creek	10/17/14
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20141017	TC-US69	Tar Creek	10/17/14
OU5_SW_All_T	OU5_SW_TC_T	TCM111914	TCM	Tar Creek	11/19/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL111914	TCSL	Tar Creek	11/19/14
OU5_SW_All_T	OU5_SW_TC_T	106TC120914-S	106TC	Tar Creek	12/09/14
OU5_SW_All_T	OU5_SW_TC_T	TCM121014	TCM	Tar Creek	12/10/14
OU5_SW_All_T	OU5_SW_TC_T	TCSL121014	TCSL	Tar Creek	12/10/14
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20141216	UT-P	Tar Creek	12/16/14
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20150106	TC-R	Tar Creek	01/06/15
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20150106	TC-US69	Tar Creek	01/06/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20150106	MR-UTD	Tar Creek	01/06/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20150106	MR-UTU	Tar Creek	01/06/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150106	UT-P	Tar Creek	01/06/15
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20150106	MR-SB	Tar Creek	01/06/15
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20150106	M-SA	Tar Creek	01/06/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150206	UT-P	Tar Creek	02/06/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150309	UT-P	Tar Creek	03/09/15
OU5_SW_All_T	OU5_SW_TC_T	106TC033115-S	106TC	Tar Creek	03/31/15
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20150417	TC-R	Tar Creek	04/17/15
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20150417	UT-R	Tar Creek	04/17/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20150417	MR-UTD	Tar Creek	04/17/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20150417	MR-UTU	Tar Creek	04/17/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150417	UT-P	Tar Creek	04/17/15
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20150417	TC-US69	Tar Creek	04/17/15
OU5_SW_All_T	OU5_SW_TC_T	TCM042815	TCM	Tar Creek	04/28/15
OU5_SW_All_T	OU5_SW_TC_T	TCSL042815	TCSL	Tar Creek	04/28/15

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150512	UT-P	Tar Creek	05/12/15
OU5_SW_All_T	OU5_SW_TC_T	TCM051815	TCM	Tar Creek	05/18/15
OU5_SW_All_T	OU5_SW_TC_T	TCSL051815	TCSL	Tar Creek	05/18/15
OU5_SW_All_T	OU5_SW_TC_T	TCM061615	TCM	Tar Creek	06/16/15
OU5_SW_All_T	OU5_SW_TC_T	TCSL061615	TCSL	Tar Creek	06/16/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150619	UT-P	Tar Creek	06/19/15
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20150710	UT-R	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20150710	TC-US69	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20150710	MR-UTD	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20150710	MR-UTU	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150710	UT-P	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20150710	MR-SB	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20150710	M-SA	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20150710	TC-R	Tar Creek	07/10/15
OU5_SW_All_T	OU5_SW_TC_T	TCM071515	TCM	Tar Creek	07/15/15
OU5_SW_All_T	OU5_SW_TC_T	TCSL071515	TCSL	Tar Creek	07/15/15
OU5_SW_All_T	OU5_SW_TC_T	106TC072715-S	106TC	Tar Creek	07/27/15
OU5_SW_All_T	OU5_SW_TC_T	TCM081715	TCM	Tar Creek	08/17/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150820	UT-P	Tar Creek	08/20/15
OU5_SW_All_T	OU5_SW_TC_T	TCM091515	TCM	Tar Creek	09/15/15
OU5_SW_All_T	OU5_SW_TC_T	TCSL091515	TCSL	Tar Creek	09/15/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20150919	UT-P	Tar Creek	09/19/15
OU5_SW_All_T	OU5_SW_TC_T	TC-R_20151009	TC-R	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	UT-R_20151009	UT-R	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTD_20151009	MR-UTD	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	MR-UTU_20151009	MR-UTU	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20151009	UT-P	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	MR-SB_20151009	MR-SB	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	M-SA_20151009	M-SA	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	TC-US69_20151009	TC-US69	Tar Creek	10/09/15
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20151114	UT-P	Tar Creek	11/14/15

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_TC_T	UT-P_20151218	UT-P	Tar Creek	12/18/15
OU5_SW_All_T	OU5_SW_TC_T	TCM011316	TCM	Tar Creek	01/13/16
OU5_SW_All_T	OU5_SW_TC_T	TCSL011316	TCSL	Tar Creek	01/13/16
OU5_SW_All_T	OU5_SW_TC_T	TCM021616	TCM	Tar Creek	02/16/16
OU5_SW_All_T	OU5_SW_TC_T	TCSL021616	TCSL	Tar Creek	02/16/16
OU5_SW_All_T	OU5_SW_TC_T	TCM032216	TCM	Tar Creek	03/22/16
OU5_SW_All_T	OU5_SW_TC_T	TCSL032216	TCSL	Tar Creek	03/22/16
OU5_SW_All_T	OU5_SW_TC_T	TCM041916	TCM	Tar Creek	04/19/16
OU5_SW_All_T	OU5_SW_TC_T	TCSL041916	TCSL	Tar Creek	04/19/16
OU5_SW_All_T	OU5_SW_TC_T	TCM051816	TCM	Tar Creek	05/18/16
OU5_SW_All_T	OU5_SW_TC_T	TCSL051816	TCSL	Tar Creek	05/18/16
OU5_SW_All_T	OU5_SW_TC_T	TCM061516	TCM	Tar Creek	06/15/16
OU5_SW_All_T	OU5_SW_TC_T	TCSL061516	TCSL	Tar Creek	06/15/16
OU5_SW_All_T	OU5_SW_TC_T	TC-SW-FS-01	TC FS 01	Tar Creek	07/13/17
OU5_SW_All_T	OU5_SW_TC_T	TC-SW-FS-02	TC FS 02	Tar Creek	07/24/17
OU5_SW_All_T	OU5_SW_TC_T	TC-SW-FS-03	TC FS 03	Tar Creek	07/26/17
OU5_SW_All_T	OU5_SW_TC_T	TC-SW-AR-01	TC AR 01	Tar Creek	11/01/17
OU5_SW_All_T	OU5_SW_NR_T	302959_20011018	TC-NRECC	Neosho River	10/18/01
OU5_SW_All_T	OU5_SW_NR_T	303987_20011106	TC-NRRP	Neosho River	11/06/01
OU5_SW_All_T	OU5_SW_NR_T	303988_20011108	TC-NRCB	Neosho River	11/08/01
OU5_SW_All_T	OU5_SW_NR_T	348061_20040305	07185000	Neosho River	03/05/04
OU5_SW_All_T	OU5_SW_NR_T	349308_20040329	07185000	Neosho River	03/29/04
OU5_SW_All_T	OU5_SW_NR_T	351317_20040505	07185000	Neosho River	05/05/04
OU5_SW_All_T	OU5_SW_NR_T	353486_20040609	07185000	Neosho River	06/09/04
OU5_SW_All_T	OU5_SW_NR_T	353582_20040614	07185000	Neosho River	06/14/04
OU5_SW_All_T	OU5_SW_NR_T	356462_20040719	07185000	Neosho River	07/19/04
OU5_SW_All_T	OU5_SW_NR_T	357688_20040803	07185000	Neosho River	08/03/04
OU5_SW_All_T	OU5_SW_NR_T	359696_20040831	07185000	Neosho River	08/31/04
OU5_SW_All_T	OU5_SW_NR_T	360600_20040914	07185000	Neosho River	09/14/04
OU5_SW_All_T	OU5_SW_NR_T	360727_20040921	07185000	Neosho River	09/21/04
OU5_SW_All_T	OU5_SW_NR_T	361390_20040928	07185000	Neosho River	09/28/04

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_NR_T	363795_20041109	07185000	Neosho River	11/09/04
OU5_SW_All_T	OU5_SW_NR_T	367141_20050107	07185000	Neosho River	01/07/05
OU5_SW_All_T	OU5_SW_NR_T	371077_20050315	07185000	Neosho River	03/15/05
OU5_SW_All_T	OU5_SW_NR_T	372739_20050414	07185000	Neosho River	04/14/05
OU5_SW_All_T	OU5_SW_NR_T	374261_20050510	07185000	Neosho River	05/10/05
OU5_SW_All_T	OU5_SW_NR_T	374523_20050516	07185000	Neosho River	05/16/05
OU5_SW_All_T	OU5_SW_NR_T	375306_20050525	07185000	Neosho River	05/25/05
OU5_SW_All_T	OU5_SW_NR_T	376193_20050608	07185000	Neosho River	06/08/05
OU5_SW_All_T	OU5_SW_NR_T	376531_20050614	07185000	Neosho River	06/14/05
OU5_SW_All_T	OU5_SW_NR_T	377761_20050630	07185000	Neosho River	06/30/05
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20050705	Lit. Elm	Neosho River	07/05/05
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20051006	Lit. Elm	Neosho River	10/06/05
OU5_SW_All_T	OU5_SW_NR_T	1187_20060430	07185000	Neosho River	04/30/06
OU5_SW_All_T	OU5_SW_NR_T	1080_20060502	NR-001	Neosho River	05/02/06
OU5_SW_All_T	OU5_SW_NR_T	1103_20060503	NR-007	Neosho River	05/03/06
OU5_SW_All_T	OU5_SW_NR_T	1104_20060503	NR-006	Neosho River	05/03/06
OU5_SW_All_T	OU5_SW_NR_T	1114_20060504	NR-BK01	Neosho River	05/04/06
OU5_SW_All_T	OU5_SW_NR_T	106NR1110806-F	106NR1	Neosho River	11/08/06
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20070104	Lit. Elm	Neosho River	01/04/07
OU5_SW_All_T	OU5_SW_NR_T	106LE010807-F	106LE	Neosho River	01/08/07
OU5_SW_All_T	OU5_SW_NR_T	106NR1010807-F	106NR1	Neosho River	01/08/07
OU5_SW_All_T	OU5_SW_NR_T	106LE030507-F	106LE	Neosho River	03/05/07
OU5_SW_All_T	OU5_SW_NR_T	106NR1030507-F	106NR1	Neosho River	03/05/07
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20070405	Lit. Elm	Neosho River	04/05/07
OU5_SW_All_T	OU5_SW_NR_T	106LE050707-F	106LE	Neosho River	05/07/07
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20070705	Lit. Elm	Neosho River	07/05/07
OU5_SW_All_T	OU5_SW_NR_T	106NR1080607-F	106NR1	Neosho River	08/06/07
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20071004	Lit. Elm	Neosho River	10/04/07
OU5_SW_All_T	OU5_SW_NR_T	106LE100907-F	106LE	Neosho River	10/09/07
OU5_SW_All_T	OU5_SW_NR_T	106NR1100907-F	106NR1	Neosho River	10/09/07
OU5_SW_All_T	OU5_SW_NR_T	106LE010708-F	106LE	Neosho River	01/07/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_NR_T	106NR1010708-F	106NR1	Neosho River	01/07/08
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20080107	Lit. Elm	Neosho River	01/07/08
OU5_SW_All_T	OU5_SW_NR_T	106LE031008-F	106LE	Neosho River	03/10/08
OU5_SW_All_T	OU5_SW_NR_T	106NR1031008-F	106NR1	Neosho River	03/10/08
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20080403	Lit. Elm	Neosho River	04/03/08
OU5_SW_All_T	OU5_SW_NR_T	LIT. ELM_20080709	Lit. Elm	Neosho River	07/09/08
OU5_SW_All_T	OU5_SW_NR_T	106LE071608-F	106LE	Neosho River	07/16/08
OU5_SW_All_T	OU5_SW_NR_T	106NR1071608-F	106NR1	Neosho River	07/16/08
OU5_SW_All_T	OU5_SW_NR_T	106LE090808-F	106LE	Neosho River	09/08/08
OU5_SW_All_T	OU5_SW_NR_T	106LE100708-F	106LE	Neosho River	10/07/08
OU5_SW_All_T	OU5_SW_NR_T	106LE120808-F	106LE	Neosho River	12/08/08
OU5_SW_All_T	OU5_SW_NR_T	106LE021709-F	106LE	Neosho River	02/17/09
OU5_SW_All_T	OU5_SW_NR_T	106LE071309-F	106LE	Neosho River	07/13/09
OU5_SW_All_T	OU5_SW_NR_T	106LE110909-F	106LE	Neosho River	11/09/09
OU5_SW_All_T	OU5_SW_NR_T	106LE012510-F	106LE	Neosho River	01/25/10
OU5_SW_All_T	OU5_SW_NR_T	106LE033110-F	106LE	Neosho River	03/31/10
OU5_SW_All_T	OU5_SW_NR_T	106LE062310-F	106LE	Neosho River	06/23/10
OU5_SW_All_T	OU5_SW_NR_T	106NR1062310-S	106NR1	Neosho River	06/23/10
OU5_SW_All_T	OU5_SW_NR_T	106NR1082310-S	106NR1	Neosho River	08/23/10
OU5_SW_All_T	OU5_SW_NR_T	106LE120412-S	106LE	Neosho River	12/04/12
OU5_SW_All_T	OU5_SW_NR_T	106NR1120412-S	106NR1	Neosho River	12/04/12
OU5_SW_All_T	OU5_SW_NR_T	106LE042913-S	106LE	Neosho River	04/29/13
OU5_SW_All_T	OU5_SW_NR_T	106NR1042913-S	106NR1	Neosho River	04/29/13
OU5_SW_All_T	OU5_SW_NR_T	106NR1072513-S	106NR1	Neosho River	07/25/13
OU5_SW_All_T	OU5_SW_NR_T	106LE021914-S	106LE	Neosho River	02/19/14
OU5_SW_All_T	OU5_SW_NR_T	106NR1021914-S	106NR1	Neosho River	02/19/14
OU5_SW_All_T	OU5_SW_NR_T	106NR1031111-S	106NR1	Neosho River	03/11/14
OU5_SW_All_T	OU5_SW_NR_T	106LE061714-S	106LE	Neosho River	06/17/14
OU5_SW_All_T	OU5_SW_NR_T	106NR1061714-S	106NR1	Neosho River	06/17/14
OU5_SW_All_T	OU5_SW_NR_T	106LE033115-S	106LE	Neosho River	03/31/15
OU5_SW_All_T	OU5_SW_NR_T	106NR1033115-S	106NR1	Neosho River	03/31/15

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_NR_T	106NR1072715-S	106NR1	Neosho River	07/27/15
OU5_SW_All_T	OU5_SW_NR_T	NR-SW-FS-01	NR FS 01	Neosho River	07/25/17
OU5_SW_All_T	OU5_SW_NR_T	NR-SW-FS-02	NR FS 02	Neosho River	09/19/17
OU5_SW_All_T	OU5_SW_NR_T	NR-SW-FS-03	NR FS 03	Neosho River	09/21/17
OU5_SW_All_T	OU5_SW_NR_T	NR-SW-MS-02	NR MS 02	Neosho River	10/30/17
OU5_SW_All_T	OU5_SW_NR_T	NR-SW-DW-01	NR DW 01	Neosho River	11/01/17
OU5_SW_All_T	OU5_SW_BC_T	07188005_WS_20000314	07188005	Beaver Creek	03/14/00
OU5_SW_All_T	OU5_SW_BC_T	07188007_WS_20000314	07188007	Beaver Creek	03/14/00
OU5_SW_All_T	OU5_SW_BC_T	07188000_WS_20000316	07188000	Beaver Creek	03/16/00
OU5_SW_All_T	OU5_SW_BC_T	07188000_WS_20000411	07188000	Beaver Creek	04/11/00
OU5_SW_All_T	OU5_SW_BC_T	07188005_WS_20000411	07188005	Beaver Creek	04/11/00
OU5_SW_All_T	OU5_SW_BC_T	07188007_WS_20000413	07188007	Beaver Creek	04/13/00
OU5_SW_All_T	OU5_SW_BC_T	07188000_WS_20000516	07188000	Beaver Creek	05/16/00
OU5_SW_All_T	OU5_SW_BC_T	07188007_WS_20000517	07188007	Beaver Creek	05/17/00
OU5_SW_All_T	OU5_SW_BC_T	07188005_WS_20000517	07188005	Beaver Creek	05/17/00
OU5_SW_All_T	OU5_SW_BC_T	07188007_WS_20000620	07188007	Beaver Creek	06/20/00
OU5_SW_All_T	OU5_SW_BC_T	07188005_WS_20000620	07188005	Beaver Creek	06/20/00
OU5_SW_All_T	OU5_SW_BC_T	07188000_WS_20000621	07188000	Beaver Creek	06/21/00
OU5_SW_All_T	OU5_SW_BC_T	07188000_WS_20000711	07188000	Beaver Creek	07/11/00
OU5_SW_All_T	OU5_SW_BC_T	07188007_WS_20000711	07188007	Beaver Creek	07/11/00
OU5_SW_All_T	OU5_SW_BC_T	07188005_WS_20000711	07188005	Beaver Creek	07/11/00
OU5_SW_All_T	OU5_SW_BC_T	07188000_WS_20000807	07188000	Beaver Creek	08/07/00
OU5_SW_All_T	OU5_SW_BC_T	07188007_WS_20000807	07188007	Beaver Creek	08/07/00
OU5_SW_All_T	OU5_SW_BC_T	07188005_WS_20000808	07188005	Beaver Creek	08/08/00
OU5_SW_All_T	OU5_SW_BC_T	348062_20040304	07188000	Beaver Creek	03/04/04
OU5_SW_All_T	OU5_SW_BC_T	349309_20040329	07188000	Beaver Creek	03/29/04
OU5_SW_All_T	OU5_SW_BC_T	351318_20040505	07188000	Beaver Creek	05/05/04
OU5_SW_All_T	OU5_SW_BC_T	353485_20040608	07188000	Beaver Creek	06/08/04
OU5_SW_All_T	OU5_SW_BC_T	353581_20040614	07188000	Beaver Creek	06/14/04
OU5_SW_All_T	OU5_SW_BC_T	356468_20040720	07188000	Beaver Creek	07/20/04
OU5_SW_All_T	OU5_SW_BC_T	357698_20040804	07188000	Beaver Creek	08/04/04

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	358874_20040820	07188000	Beaver Creek	08/20/04
OU5_SW_All_T	OU5_SW_BC_T	359487_20040831	07188000	Beaver Creek	08/31/04
OU5_SW_All_T	OU5_SW_BC_T	359699_20040901	07188000	Beaver Creek	09/01/04
OU5_SW_All_T	OU5_SW_BC_T	360602_20040915	07188000	Beaver Creek	09/15/04
OU5_SW_All_T	OU5_SW_BC_T	361393_20040929	07188000	Beaver Creek	09/29/04
OU5_SW_All_T	OU5_SW_BC_T	363450_20041102	07188000	Beaver Creek	11/02/04
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20041105	BC-S630	Beaver Creek	11/05/04
OU5_SW_All_T	OU5_SW_BC_T	363800_20041110	07188000	Beaver Creek	11/10/04
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20041210	BC-S630	Beaver Creek	12/10/04
OU5_SW_All_T	OU5_SW_BC_T	367142_20050107	07188000	Beaver Creek	01/07/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050107	BC-S630	Beaver Creek	01/07/05
OU5_SW_All_T	OU5_SW_BC_T	BCB11105WS	BCB	Beaver Creek	01/11/05
OU5_SW_All_T	OU5_SW_BC_T	BC4011105WS	BC40	Beaver Creek	01/11/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050211	BC-S630	Beaver Creek	02/11/05
OU5_SW_All_T	OU5_SW_BC_T	BCB21605WS	BCB	Beaver Creek	02/16/05
OU5_SW_All_T	OU5_SW_BC_T	BC4021605WS	BC40	Beaver Creek	02/16/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050311	BC-S630	Beaver Creek	03/11/05
OU5_SW_All_T	OU5_SW_BC_T	371079_20050315	07188000	Beaver Creek	03/15/05
OU5_SW_All_T	OU5_SW_BC_T	BC4031705WS	BC40	Beaver Creek	03/17/05
OU5_SW_All_T	OU5_SW_BC_T	BCB31705WS	BCB	Beaver Creek	03/17/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050408	BC-S630	Beaver Creek	04/08/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20050408	BC-E50	Beaver Creek	04/08/05
OU5_SW_All_T	OU5_SW_BC_T	BCB041805SW	BCB	Beaver Creek	04/18/05
OU5_SW_All_T	OU5_SW_BC_T	BC40041805SW	BC40	Beaver Creek	04/18/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050506	BC-S630	Beaver Creek	05/06/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20050506	BC-E50	Beaver Creek	05/06/05
OU5_SW_All_T	OU5_SW_BC_T	374260_20050510	07188000	Beaver Creek	05/10/05
OU5_SW_All_T	OU5_SW_BC_T	374524_20050516	07188000	Beaver Creek	05/16/05
OU5_SW_All_T	OU5_SW_BC_T	BC40051705SW	BC40	Beaver Creek	05/17/05
OU5_SW_All_T	OU5_SW_BC_T	BCB051705SW	BCB	Beaver Creek	05/17/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050602	BC-S630	Beaver Creek	06/02/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20050602	BC-E50	Beaver Creek	06/02/05
OU5_SW_All_T	OU5_SW_BC_T	376185_20050607	07188000	Beaver Creek	06/07/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-075_20050610	TCSW075	Beaver Creek	06/10/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-076_20050610	TCSW076	Beaver Creek	06/10/05
OU5_SW_All_T	OU5_SW_BC_T	376532_20050614	07188000	Beaver Creek	06/14/05
OU5_SW_All_T	OU5_SW_BC_T	BCB061505SW	BCB	Beaver Creek	06/15/05
OU5_SW_All_T	OU5_SW_BC_T	BC40061505SW	BC40	Beaver Creek	06/15/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-128_20050623	TCSW128	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-129_20050623	TCSW129	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-130_20050623	TCSW130	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-131_20050623	TCSW131	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-132_20050623	TCSW132	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-133_20050623	TCSW133	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-134_20050623	TCSW134	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-135_20050623	TCSW135	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-136_20050623	TCSW136	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-137_20050623	TCSW137	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-138_20050623	TCSW138	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-139_20050623	TCSW139	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-140_20050623	TCSW140	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-141_20050623	TCSW141	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-142_20050623	TCSW142	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-143_20050623	TCSW143	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-144_20050623	TCSW144	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-145_20050623	TCSW145	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-146_20050623	TCSW146	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-147_20050623	TCSW147	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	TCSW-148_20050623	TCSW148	Beaver Creek	06/23/05
OU5_SW_All_T	OU5_SW_BC_T	377762_20050629	07188000	Beaver Creek	06/29/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050706	BC-S630	Beaver Creek	07/06/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20050706	BC-E50	Beaver Creek	07/06/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BCB071305SW	BCB	Beaver Creek	07/13/05
OU5_SW_All_T	OU5_SW_BC_T	BC40071305SW	BC40	Beaver Creek	07/13/05
OU5_SW_All_T	OU5_SW_BC_T	1877_20050715	07188007	Beaver Creek	07/15/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050803	BC-S630	Beaver Creek	08/03/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20050803	BC-E50	Beaver Creek	08/03/05
OU5_SW_All_T	OU5_SW_BC_T	BCB082405SW	BCB	Beaver Creek	08/24/05
OU5_SW_All_T	OU5_SW_BC_T	BC40082405SW	BC40	Beaver Creek	08/24/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20050909	BC-S630	Beaver Creek	09/09/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20050909	BC-E50	Beaver Creek	09/09/05
OU5_SW_All_T	OU5_SW_BC_T	BCB092005SW	BCB	Beaver Creek	09/20/05
OU5_SW_All_T	OU5_SW_BC_T	BC40092005SW	BC40	Beaver Creek	09/20/05
OU5_SW_All_T	OU5_SW_BC_T	1860_20050927	07188000	Beaver Creek	09/27/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20051007	BC-S630	Beaver Creek	10/07/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20051007	BC-E50	Beaver Creek	10/07/05
OU5_SW_All_T	OU5_SW_BC_T	BC40101205SW	BC40	Beaver Creek	10/12/05
OU5_SW_All_T	OU5_SW_BC_T	BCB101305SW	BCB	Beaver Creek	10/13/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20051104	BC-S630	Beaver Creek	11/04/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20051104	BC-E50	Beaver Creek	11/04/05
OU5_SW_All_T	OU5_SW_BC_T	BCB113005SW	BCB	Beaver Creek	11/30/05
OU5_SW_All_T	OU5_SW_BC_T	BC40113005SW	BC40	Beaver Creek	11/30/05
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20051202	BC-E50	Beaver Creek	12/02/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20051202	BC-S630	Beaver Creek	12/02/05
OU5_SW_All_T	OU5_SW_BC_T	BCB122705SW	BCB	Beaver Creek	12/27/05
OU5_SW_All_T	OU5_SW_BC_T	BC40122705SW	BC40	Beaver Creek	12/27/05
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060110	BC-S630	Beaver Creek	01/10/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060110	BC-E50	Beaver Creek	01/10/06
OU5_SW_All_T	OU5_SW_BC_T	BCB011106SW	BCB	Beaver Creek	01/11/06
OU5_SW_All_T	OU5_SW_BC_T	BC40011106SW	BC40	Beaver Creek	01/11/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060203	BC-S630	Beaver Creek	02/03/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060203	BC-E50	Beaver Creek	02/03/06
OU5_SW_All_T	OU5_SW_BC_T	BCB021306SW	BCB	Beaver Creek	02/13/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BC40021306SW	BC40	Beaver Creek	02/13/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060303	BC-S630	Beaver Creek	03/03/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060303	BC-E50	Beaver Creek	03/03/06
OU5_SW_All_T	OU5_SW_BC_T	BCB031506SW	BCB	Beaver Creek	03/15/06
OU5_SW_All_T	OU5_SW_BC_T	BC40031506SW	BC40	Beaver Creek	03/15/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060406	BC-S630	Beaver Creek	04/06/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060406	BC-E50	Beaver Creek	04/06/06
OU5_SW_All_T	OU5_SW_BC_T	BCB041206SW	BCB	Beaver Creek	04/12/06
OU5_SW_All_T	OU5_SW_BC_T	BC40041206SW	BC40	Beaver Creek	04/12/06
OU5_SW_All_T	OU5_SW_BC_T	1861_20060430	07188000	Beaver Creek	04/30/06
OU5_SW_All_T	OU5_SW_BC_T	1065_20060501	SR-702	Beaver Creek	05/01/06
OU5_SW_All_T	OU5_SW_BC_T	1099_20060502	SR-701	Beaver Creek	05/02/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060505	BC-S630	Beaver Creek	05/05/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060505	BC-E50	Beaver Creek	05/05/06
OU5_SW_All_T	OU5_SW_BC_T	BC40051606SW	BC40	Beaver Creek	05/16/06
OU5_SW_All_T	OU5_SW_BC_T	BCB051606SW	BCB	Beaver Creek	05/16/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060607	BC-S630	Beaver Creek	06/07/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060607	BC-E50	Beaver Creek	06/07/06
OU5_SW_All_T	OU5_SW_BC_T	BCB061306SW	BCB	Beaver Creek	06/13/06
OU5_SW_All_T	OU5_SW_BC_T	BC40061306SW	BC40	Beaver Creek	06/13/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060707	BC-S630	Beaver Creek	07/07/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060707	BC-E50	Beaver Creek	07/07/06
OU5_SW_All_T	OU5_SW_BC_T	BCB072006SW	BCB	Beaver Creek	07/20/06
OU5_SW_All_T	OU5_SW_BC_T	BC40072006SW	BC40	Beaver Creek	07/20/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060802	BC-S630	Beaver Creek	08/02/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060802	BC-E50	Beaver Creek	08/02/06
OU5_SW_All_T	OU5_SW_BC_T	BCB081706SW	BCB	Beaver Creek	08/17/06
OU5_SW_All_T	OU5_SW_BC_T	BC40081706SW	BC40	Beaver Creek	08/17/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20060908	BC-S630	Beaver Creek	09/08/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20060908	BC-E50	Beaver Creek	09/08/06
OU5_SW_All_T	OU5_SW_BC_T	BCB091206SW	BCB	Beaver Creek	09/12/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BC40091206SW	BC40	Beaver Creek	09/12/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20061006	BC-S630	Beaver Creek	10/06/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20061006	BC-E50	Beaver Creek	10/06/06
OU5_SW_All_T	OU5_SW_BC_T	BCB101806SW	BCB	Beaver Creek	10/18/06
OU5_SW_All_T	OU5_SW_BC_T	BC40101806SW	BC40	Beaver Creek	10/18/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20061103	BC-S630	Beaver Creek	11/03/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20061103	BC-E50	Beaver Creek	11/03/06
OU5_SW_All_T	OU5_SW_BC_T	BCB111606SW	BCB	Beaver Creek	11/16/06
OU5_SW_All_T	OU5_SW_BC_T	BC40111606SW	BC40	Beaver Creek	11/16/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20061204	BC-S630	Beaver Creek	12/04/06
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20061204	BC-E50	Beaver Creek	12/04/06
OU5_SW_All_T	OU5_SW_BC_T	BCB121406SW	BCB	Beaver Creek	12/14/06
OU5_SW_All_T	OU5_SW_BC_T	BC40121406SW	BC40	Beaver Creek	12/14/06
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070105	BC-S630	Beaver Creek	01/05/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070105	BC-E50	Beaver Creek	01/05/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070202	BC-S630	Beaver Creek	02/02/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070202	BC-E50	Beaver Creek	02/02/07
OU5_SW_All_T	OU5_SW_BC_T	BCB022107SW	BCB	Beaver Creek	02/21/07
OU5_SW_All_T	OU5_SW_BC_T	BC40022107SW	BC40	Beaver Creek	02/21/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070302	BC-S630	Beaver Creek	03/02/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070302	BC-E50	Beaver Creek	03/02/07
OU5_SW_All_T	OU5_SW_BC_T	BCB032107SW	BCB	Beaver Creek	03/21/07
OU5_SW_All_T	OU5_SW_BC_T	BC40032107SW	BC40	Beaver Creek	03/21/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070406	BC-S630	Beaver Creek	04/06/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070406	BC-E50	Beaver Creek	04/06/07
OU5_SW_All_T	OU5_SW_BC_T	BCB041907SW	BCB	Beaver Creek	04/19/07
OU5_SW_All_T	OU5_SW_BC_T	BC40041907SW	BC40	Beaver Creek	04/19/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070504	BC-S630	Beaver Creek	05/04/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070504	BC-E50	Beaver Creek	05/04/07
OU5_SW_All_T	OU5_SW_BC_T	BCB053107SW	BCB	Beaver Creek	05/31/07
OU5_SW_All_T	OU5_SW_BC_T	BC40053107SW	BC40	Beaver Creek	05/31/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070601	BC-S630	Beaver Creek	06/01/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070601	BC-E50	Beaver Creek	06/01/07
OU5_SW_All_T	OU5_SW_BC_T	BCB062707SW	BCB	Beaver Creek	06/27/07
OU5_SW_All_T	OU5_SW_BC_T	BC40062707SW	BC40	Beaver Creek	06/27/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070706	BC-S630	Beaver Creek	07/06/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070706	BC-E50	Beaver Creek	07/06/07
OU5_SW_All_T	OU5_SW_BC_T	BCB071907SW	BCB	Beaver Creek	07/19/07
OU5_SW_All_T	OU5_SW_BC_T	BC40071907SW	BC40	Beaver Creek	07/19/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070803	BC-S630	Beaver Creek	08/03/07
OU5_SW_All_T	OU5_SW_BC_T	BC-MCK_20070803	BC-McK	Beaver Creek	08/03/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070803	BC-E50	Beaver Creek	08/03/07
OU5_SW_All_T	OU5_SW_BC_T	BCB081607SW	BCB	Beaver Creek	08/16/07
OU5_SW_All_T	OU5_SW_BC_T	BC40081607SW	BC40	Beaver Creek	08/16/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20070907	BC-S630	Beaver Creek	09/07/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20070907	BC-E50	Beaver Creek	09/07/07
OU5_SW_All_T	OU5_SW_BC_T	BCB092007SW	BCB	Beaver Creek	09/20/07
OU5_SW_All_T	OU5_SW_BC_T	BC40092007SW	BC40	Beaver Creek	09/20/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20071005	BC-S630	Beaver Creek	10/05/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20071005	BC-E50	Beaver Creek	10/05/07
OU5_SW_All_T	OU5_SW_BC_T	BCB102407SW	BCB	Beaver Creek	10/24/07
OU5_SW_All_T	OU5_SW_BC_T	BC40102407SW	BC40	Beaver Creek	10/24/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20071102	BC-S630	Beaver Creek	11/02/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20071102	BC-E50	Beaver Creek	11/02/07
OU5_SW_All_T	OU5_SW_BC_T	BCB112607SW	BCB	Beaver Creek	11/26/07
OU5_SW_All_T	OU5_SW_BC_T	BC40112607SW	BC40	Beaver Creek	11/26/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20071207	BC-S630	Beaver Creek	12/07/07
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20071207	BC-E50	Beaver Creek	12/07/07
OU5_SW_All_T	OU5_SW_BC_T	BCB121907SW	BCB	Beaver Creek	12/19/07
OU5_SW_All_T	OU5_SW_BC_T	BC40121907SW	BC40	Beaver Creek	12/19/07
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080108	BC-S630	Beaver Creek	01/08/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080108	BC-E50	Beaver Creek	01/08/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BCB010908SW	BCB	Beaver Creek	01/09/08
OU5_SW_All_T	OU5_SW_BC_T	BC40010908SW	BC40	Beaver Creek	01/09/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080201	BC-S630	Beaver Creek	02/01/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080201	BC-E50	Beaver Creek	02/01/08
OU5_SW_All_T	OU5_SW_BC_T	BCB022008SW	BCB	Beaver Creek	02/20/08
OU5_SW_All_T	OU5_SW_BC_T	BC40022008SW	BC40	Beaver Creek	02/20/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080307	BC-S630	Beaver Creek	03/07/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080307	BC-E50	Beaver Creek	03/07/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080404	BC-S630	Beaver Creek	04/04/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080404	BC-E50	Beaver Creek	04/04/08
OU5_SW_All_T	OU5_SW_BC_T	BCB041508SW	BCB	Beaver Creek	04/15/08
OU5_SW_All_T	OU5_SW_BC_T	BC40041508SW	BC40	Beaver Creek	04/15/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080509	BC-S630	Beaver Creek	05/09/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080509	BC-E50	Beaver Creek	05/09/08
OU5_SW_All_T	OU5_SW_BC_T	BCB051408SW	BCB	Beaver Creek	05/14/08
OU5_SW_All_T	OU5_SW_BC_T	BC40051408SW	BC40	Beaver Creek	05/14/08
OU5_SW_All_T	OU5_SW_BC_T	BCB060508SW	BCB	Beaver Creek	06/05/08
OU5_SW_All_T	OU5_SW_BC_T	BC40060508SW	BC40	Beaver Creek	06/05/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080606	BC-S630	Beaver Creek	06/06/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080606	BC-E50	Beaver Creek	06/06/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080710	BC-S630	Beaver Creek	07/10/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080710	BC-E50	Beaver Creek	07/10/08
OU5_SW_All_T	OU5_SW_BC_T	BCB071608SW	BCB	Beaver Creek	07/16/08
OU5_SW_All_T	OU5_SW_BC_T	BC40071608SW	BC40	Beaver Creek	07/16/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080808	BC-S630	Beaver Creek	08/08/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080808	BC-E50	Beaver Creek	08/08/08
OU5_SW_All_T	OU5_SW_BC_T	BCB082108SW	BCB	Beaver Creek	08/21/08
OU5_SW_All_T	OU5_SW_BC_T	BC40082108SW	BC40	Beaver Creek	08/21/08
OU5_SW_All_T	OU5_SW_BC_T	BC-S630_20080905	BC-S630	Beaver Creek	09/05/08
OU5_SW_All_T	OU5_SW_BC_T	BC-E50_20080905	BC-E50	Beaver Creek	09/05/08
OU5_SW_All_T	OU5_SW_BC_T	BCB092408SW	BCB	Beaver Creek	09/24/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BC40092408SW	BC40	Beaver Creek	09/24/08
OU5_SW_All_T	OU5_SW_BC_T	BCB102008SW	BCB	Beaver Creek	10/20/08
OU5_SW_All_T	OU5_SW_BC_T	BC40102008SW	BC40	Beaver Creek	10/20/08
OU5_SW_All_T	OU5_SW_BC_T	BCB111708SW	BCB	Beaver Creek	11/17/08
OU5_SW_All_T	OU5_SW_BC_T	BC40111708SW	BC40	Beaver Creek	11/17/08
OU5_SW_All_T	OU5_SW_BC_T	BCB121908SW	BCB	Beaver Creek	12/19/08
OU5_SW_All_T	OU5_SW_BC_T	BC40121908SW	BC40	Beaver Creek	12/19/08
OU5_SW_All_T	OU5_SW_BC_T	BCB012209SW	BCB	Beaver Creek	01/22/09
OU5_SW_All_T	OU5_SW_BC_T	BC40012209SW	BC40	Beaver Creek	01/22/09
OU5_SW_All_T	OU5_SW_BC_T	BCB022609SW	BCB	Beaver Creek	02/26/09
OU5_SW_All_T	OU5_SW_BC_T	BC40022609SW	BC40	Beaver Creek	02/26/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZR2	RVR0004-0016SW	Beaver Creek	03/08/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZR0	RVR0004-0015SW	Beaver Creek	03/08/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZQ8	RVR0004-0014SW	Beaver Creek	03/08/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZQ2	RVR0004-0011SW	Beaver Creek	03/09/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZQ4	RVR0004-0012SW	Beaver Creek	03/10/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZQ6	RVR0004-0013SW	Beaver Creek	03/10/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZQ0	RVR0004-0010SW	Beaver Creek	03/11/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZP8	RVR0004-0009SW	Beaver Creek	03/11/09
OU5_SW_All_T	OU5_SW_BC_T	MF2ZP6	RVR0004-0008SW	Beaver Creek	03/11/09
OU5_SW_All_T	OU5_SW_BC_T	RVR0004-0007SW	RVR0004-0007SW	Beaver Creek	03/18/09
OU5_SW_All_T	OU5_SW_BC_T	BCB031909SW	BCB	Beaver Creek	03/19/09
OU5_SW_All_T	OU5_SW_BC_T	BC40032009SW	BC40	Beaver Creek	03/20/09
OU5_SW_All_T	OU5_SW_BC_T	BCB012510	BCB	Beaver Creek	01/25/10
OU5_SW_All_T	OU5_SW_BC_T	BC40012510	BC40	Beaver Creek	01/25/10
OU5_SW_All_T	OU5_SW_BC_T	BCB021810	BCB	Beaver Creek	02/18/10
OU5_SW_All_T	OU5_SW_BC_T	BC40021810	BC40	Beaver Creek	02/18/10
OU5_SW_All_T	OU5_SW_BC_T	BC40031810	BC40	Beaver Creek	03/18/10
OU5_SW_All_T	OU5_SW_BC_T	BCB031810	BCB	Beaver Creek	03/18/10
OU5_SW_All_T	OU5_SW_BC_T	RVR0004-0005SW	RVR0004-0005	Beaver Creek	11/14/11
OU5_SW_All_T	OU5_SW_BC_T	RVR0004-0004SW	RVR0004-0004	Beaver Creek	11/15/11

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	RVR0004-0003SW	RVR0004-0003	Beaver Creek	11/15/11
OU5_SW_All_T	OU5_SW_BC_T	RVR0004-0001SW	RVR0004-0001	Beaver Creek	11/15/11
OU5_SW_All_T	OU5_SW_BC_T	RVR0004-0006SW	RVR0004-0006	Beaver Creek	11/16/11
OU5_SW_All_T	OU5_SW_BC_T	BC40011314	BC40	Beaver Creek	01/13/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG011314	BCPG	Beaver Creek	01/13/14
OU5_SW_All_T	OU5_SW_BC_T	BC40021314	BC40	Beaver Creek	02/13/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG021314	BCPG	Beaver Creek	02/13/14
OU5_SW_All_T	OU5_SW_BC_T	BC40031314	BC40	Beaver Creek	03/13/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG031314	BCPG	Beaver Creek	03/13/14
OU5_SW_All_T	OU5_SW_BC_T	BC40040914	BC40	Beaver Creek	04/09/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG040914	BCPG	Beaver Creek	04/09/14
OU5_SW_All_T	OU5_SW_BC_T	BC40051314	BC40	Beaver Creek	05/13/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG051314	BCPG	Beaver Creek	05/13/14
OU5_SW_All_T	OU5_SW_BC_T	BC40061614	BC40	Beaver Creek	06/16/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG061614	BCPG	Beaver Creek	06/16/14
OU5_SW_All_T	OU5_SW_BC_T	BC40071414	BC40	Beaver Creek	07/14/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG071414	BCPG	Beaver Creek	07/14/14
OU5_SW_All_T	OU5_SW_BC_T	BC40081314	BC40	Beaver Creek	08/13/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG081314	BCPG	Beaver Creek	08/13/14
OU5_SW_All_T	OU5_SW_BC_T	BC40091514	BC40	Beaver Creek	09/15/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG091514	BCPG	Beaver Creek	09/15/14
OU5_SW_All_T	OU5_SW_BC_T	BC40101614	BC40	Beaver Creek	10/16/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG101614	BCPG	Beaver Creek	10/16/14
OU5_SW_All_T	OU5_SW_BC_T	BC40111914	BC40	Beaver Creek	11/19/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG111914	BCPG	Beaver Creek	11/19/14
OU5_SW_All_T	OU5_SW_BC_T	BC40121014	BC40	Beaver Creek	12/10/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG121014	BCPG	Beaver Creek	12/10/14
OU5_SW_All_T	OU5_SW_BC_T	BCPG042815	BCPG	Beaver Creek	04/28/15
OU5_SW_All_T	OU5_SW_BC_T	BC40042815	BC40	Beaver Creek	04/28/15
OU5_SW_All_T	OU5_SW_BC_T	BC40051815	BC40	Beaver Creek	05/18/15
OU5_SW_All_T	OU5_SW_BC_T	BCPG051815	BCPG	Beaver Creek	05/18/15

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_BC_T	BC40061615	BC40	Beaver Creek	06/16/15
OU5_SW_All_T	OU5_SW_BC_T	BCPG061615	BCPG	Beaver Creek	06/16/15
OU5_SW_All_T	OU5_SW_BC_T	BC40071515	BC40	Beaver Creek	07/15/15
OU5_SW_All_T	OU5_SW_BC_T	BCPG071515	BCPG	Beaver Creek	07/15/15
OU5_SW_All_T	OU5_SW_BC_T	BC40081715	BC40	Beaver Creek	08/17/15
OU5_SW_All_T	OU5_SW_BC_T	BCPG081715	BCPG	Beaver Creek	08/17/15
OU5_SW_All_T	OU5_SW_BC_T	BC40091515	BC40	Beaver Creek	09/15/15
OU5_SW_All_T	OU5_SW_BC_T	BCPG091515	BCPG	Beaver Creek	09/15/15
OU5_SW_All_T	OU5_SW_BC_T	BC40011316	BC40	Beaver Creek	01/13/16
OU5_SW_All_T	OU5_SW_BC_T	BCPG011316	BCPG	Beaver Creek	01/13/16
OU5_SW_All_T	OU5_SW_BC_T	BC40021616	BC40	Beaver Creek	02/16/16
OU5_SW_All_T	OU5_SW_BC_T	BCPG021616	BCPG	Beaver Creek	02/16/16
OU5_SW_All_T	OU5_SW_BC_T	BC40032216	BC40	Beaver Creek	03/22/16
OU5_SW_All_T	OU5_SW_BC_T	BCPG032216	BCPG	Beaver Creek	03/22/16
OU5_SW_All_T	OU5_SW_BC_T	BC40041916	BC40	Beaver Creek	04/19/16
OU5_SW_All_T	OU5_SW_BC_T	BCPG041916	BCPG	Beaver Creek	04/19/16
OU5_SW_All_T	OU5_SW_BC_T	BC40051816	BC40	Beaver Creek	05/18/16
OU5_SW_All_T	OU5_SW_BC_T	BCPG051816	BCPG	Beaver Creek	05/18/16
OU5_SW_All_T	OU5_SW_BC_T	BC40061516	BC40	Beaver Creek	06/15/16
OU5_SW_All_T	OU5_SW_BC_T	BCPG061516	BCPG	Beaver Creek	06/15/16
OU5_SW_All_T	OU5_SW_BC_T	BC-SW-FS-01	BC FS 01	Beaver Creek	07/18/17
OU5_SW_All_T	OU5_SW_BC_T	BC-SW-FS-02	BC FS 02	Beaver Creek	07/18/17
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-01_20040324	SURT_1005	Lost Creek	03/24/04
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-02_20040324	SURT_1006	Lost Creek	03/24/04
OU5_SW_All_T	OU5_SW_LC_T	QUA-04-SWPW-55_20040324	SURT_1005	Lost Creek	03/24/04
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-05_20040519	SURT_1005	Lost Creek	05/19/04
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-06_20040519	SURT_1006	Lost Creek	05/19/04
OU5_SW_All_T	OU5_SW_LC_T	QUA-04-SWPW-56_20040519	SURT_1006	Lost Creek	05/19/04
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-09_20040811	SURT_1005	Lost Creek	08/11/04
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-10_20040811	SURT_1006	Lost Creek	08/11/04
OU5_SW_All_T	OU5_SW_LC_T	QUA-04-SWPW-57_20040811	SURT_1005	Lost Creek	08/11/04

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-13_20041108	SURT_1005	Lost Creek	11/08/04
OU5_SW_All_T	OU5_SW_LC_T	ESH-04-SWPW-14_20041108	SURT_1006	Lost Creek	11/08/04
OU5_SW_All_T	OU5_SW_LC_T	QUA-04-SWPW-58_20041108	SURT_1005	Lost Creek	11/08/04
OU5_SW_All_T	OU5_SW_LC_T	ESH-05-SWPW-01_20050210	SURT_1005	Lost Creek	02/10/05
OU5_SW_All_T	OU5_SW_LC_T	ESH-05-SWPW-02_20050210	SURT_1006	Lost Creek	02/10/05
OU5_SW_All_T	OU5_SW_LC_T	LC1050210S	LC1	Lost Creek	02/10/05
OU5_SW_All_T	OU5_SW_LC_T	LCWWT050210S	LCWWTP	Lost Creek	02/10/05
OU5_SW_All_T	OU5_SW_LC_T	MODOC050210S	MODOC	Lost Creek	02/10/05
OU5_SW_All_T	OU5_SW_LC_T	1207_20060501	LC-201	Lost Creek	05/01/06
OU5_SW_All_T	OU5_SW_LC_T	1208_20060501	LC-006	Lost Creek	05/01/06
OU5_SW_All_T	OU5_SW_LC_T	1066_20060502	LC-001	Lost Creek	05/02/06
OU5_SW_All_T	OU5_SW_LC_T	1067_20060502	LC-002	Lost Creek	05/02/06
OU5_SW_All_T	OU5_SW_LC_T	1071_20060502	LC-005	Lost Creek	05/02/06
OU5_SW_All_T	OU5_SW_LC_T	1072_20060502	LC-101	Lost Creek	05/02/06
OU5_SW_All_T	OU5_SW_LC_T	1073_20060502	LC-102	Lost Creek	05/02/06
OU5_SW_All_T	OU5_SW_LC_T	1069_20060503	LC-003	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1070_20060503	LC-004	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1152_20060503	LC-010	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1219_20060503	LC-305	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1220_20060503	LC-304	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1221_20060503	LC-303	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1222_20060503	LC-302	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1223_20060503	LC-301	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1224_20060503	LC-009	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1226_20060503	LC-BK01	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1227_20060503	LC-008	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1229_20060503	LC-203	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1230_20060503	LC-202	Lost Creek	05/03/06
OU5_SW_All_T	OU5_SW_LC_T	1231_20060504	LC-307	Lost Creek	05/04/06
OU5_SW_All_T	OU5_SW_LC_T	WN7440208	WN74	Lost Creek	04/02/08
OU5_SW_All_T	OU5_SW_LC_T	WN2432509	WN24	Lost Creek	03/25/09

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LC_T	WN5032509	WN50	Lost Creek	03/25/09
OU5_SW_All_T	OU5_SW_LC_T	WN7432509	WN74	Lost Creek	03/25/09
OU5_SW_All_T	OU5_SW_LC_T	WN2433010	WN24	Lost Creek	03/30/10
OU5_SW_All_T	OU5_SW_LC_T	WN5033010	WN50	Lost Creek	03/30/10
OU5_SW_All_T	OU5_SW_LC_T	WN7433010	WN74	Lost Creek	03/30/10
OU5_SW_All_T	OU5_SW_LC_T	WN2432111S	WN24	Lost Creek	03/21/11
OU5_SW_All_T	OU5_SW_LC_T	WN5032111S	WN50	Lost Creek	03/21/11
OU5_SW_All_T	OU5_SW_LC_T	WN7432111S	WN74	Lost Creek	03/21/11
OU5_SW_All_T	OU5_SW_LC_T	WN24042412S	WN24	Lost Creek	04/24/12
OU5_SW_All_T	OU5_SW_LC_T	WN50042412S	WN50	Lost Creek	04/24/12
OU5_SW_All_T	OU5_SW_LC_T	WN74042412S	WN74	Lost Creek	04/24/12
OU5_SW_All_T	OU5_SW_LC_T	WN24051413S	WN24	Lost Creek	05/14/13
OU5_SW_All_T	OU5_SW_LC_T	WN50051413S	WN50	Lost Creek	05/14/13
OU5_SW_All_T	OU5_SW_LC_T	WN74051413S	WN74	Lost Creek	05/14/13
OU5_SW_All_T	OU5_SW_LC_T	WN24061717S	WN24	Lost Creek	06/17/14
OU5_SW_All_T	OU5_SW_LC_T	WN50061714S	WN50	Lost Creek	06/17/14
OU5_SW_All_T	OU5_SW_LC_T	WN74061714S	WN74	Lost Creek	06/17/14
OU5_SW_All_T	OU5_SW_LC_T	WN246915S	WN24	Lost Creek	06/09/15
OU5_SW_All_T	OU5_SW_LC_T	WN506915S	WN50	Lost Creek	06/09/15
OU5_SW_All_T	OU5_SW_LC_T	WN746915S	WN74	Lost Creek	06/09/15
OU5_SW_All_T	OU5_SW_LC_T	WN2461316S	WN24	Lost Creek	06/13/16
OU5_SW_All_T	OU5_SW_LC_T	WN5061316S	WN50	Lost Creek	06/13/16
OU5_SW_All_T	OU5_SW_LC_T	WN7461316S	WN74	Lost Creek	06/13/16
OU5_SW_All_T	OU5_SW_LC_T	LC-SW-FS-01	LC FS 01	Lost Creek	07/13/17
OU5_SW_All_T	OU5_SW_LC_T	LC-SW-FS-03	LC FS 03	Lost Creek	07/13/17
OU5_SW_All_T	OU5_SW_LC_T	LC-SW-FS-02	LC FS 02	Lost Creek	07/13/17
OU5_SW_All_T	OU5_SW_LC_T	LC-SW-DW-02	LC DW 02	Lost Creek	07/26/17
OU5_SW_All_T	OU5_SW_LC_T	LC-SW-DW-01	LC DW 01	Lost Creek	07/26/17
OU5_SW_All_T	OU5_SW_LC_T	LC-SW-AR-01	LC AR 01	Lost Creek	10/31/17
OU5_SW_All_T	OU5_SW_LSR_T	07187995_WS_20000315	07187995	Lower Spring River	03/15/00
OU5_SW_All_T	OU5_SW_LSR_T	07187995_WS_20000412	07187995	Lower Spring River	04/12/00

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	07187995_WS_20000516	07187995	Lower Spring River	05/16/00
OU5_SW_All_T	OU5_SW_LSR_T	07187995_WS_20000620	07187995	Lower Spring River	06/20/00
OU5_SW_All_T	OU5_SW_LSR_T	07187995_WS_20000712	07187995	Lower Spring River	07/12/00
OU5_SW_All_T	OU5_SW_LSR_T	07187995_WS_20000807	07187995	Lower Spring River	08/07/00
OU5_SW_All_T	OU5_SW_LSR_T	302956_20011015	TC-SRBH	Lower Spring River	10/15/01
OU5_SW_All_T	OU5_SW_LSR_T	302957_20011016	TC-SRTB	Lower Spring River	10/16/01
OU5_SW_All_T	OU5_SW_LSR_T	302958_20011017	TC-SRMB	Lower Spring River	10/17/01
OU5_SW_All_T	OU5_SW_LSR_T	348063_20040305	07188180	Lower Spring River	03/05/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-03_20040324	SURT_1061	Lower Spring River	03/24/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-04_20040324	SURT_1062	Lower Spring River	03/24/04
OU5_SW_All_T	OU5_SW_LSR_T	349353_20040330	07188180	Lower Spring River	03/30/04
OU5_SW_All_T	OU5_SW_LSR_T	351312_20040504	07188180	Lower Spring River	05/04/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-07_20040519	SURT_1061	Lower Spring River	05/19/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-08_20040519	SURT_1062	Lower Spring River	05/19/04
OU5_SW_All_T	OU5_SW_LSR_T	353482_20040608	07188180	Lower Spring River	06/08/04
OU5_SW_All_T	OU5_SW_LSR_T	353664_20040615	07188180	Lower Spring River	06/15/04
OU5_SW_All_T	OU5_SW_LSR_T	356460_20040719	07188180	Lower Spring River	07/19/04
OU5_SW_All_T	OU5_SW_LSR_T	357682_20040802	07188180	Lower Spring River	08/02/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-11_20040811	SURT_1061	Lower Spring River	08/11/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-12_20040811	SURT_1062	Lower Spring River	08/11/04
OU5_SW_All_T	OU5_SW_LSR_T	359486_20040831	07188180	Lower Spring River	08/31/04
OU5_SW_All_T	OU5_SW_LSR_T	360594_20040914	07188180	Lower Spring River	09/14/04
OU5_SW_All_T	OU5_SW_LSR_T	361384_20040927	07188180	Lower Spring River	09/27/04
OU5_SW_All_T	OU5_SW_LSR_T	359690_20040930	07188180	Lower Spring River	09/30/04
OU5_SW_All_T	OU5_SW_LSR_T	363449_20041102	07188180	Lower Spring River	11/02/04
OU5_SW_All_T	OU5_SW_LSR_T	363789_20041108	07188180	Lower Spring River	11/08/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-15_20041108	SURT_1061	Lower Spring River	11/08/04
OU5_SW_All_T	OU5_SW_LSR_T	ESH-04-SWPW-16_20041108	SURT_1062	Lower Spring River	11/08/04
OU5_SW_All_T	OU5_SW_LSR_T	367144_20050107	07188180	Lower Spring River	01/07/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP11105WS	SRDP	Lower Spring River	01/11/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL11105WS	SRSL	Lower Spring River	01/11/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	345280_20050118	07188180	Lower Spring River	01/18/05
OU5_SW_All_T	OU5_SW_LSR_T	ESH-05-SWPW-03_20050210	SURT_1061	Lower Spring River	02/10/05
OU5_SW_All_T	OU5_SW_LSR_T	ESH-05-SWPW-04_20050210	SURT_1062	Lower Spring River	02/10/05
OU5_SW_All_T	OU5_SW_LSR_T	FLINT050210S	FLINT	Lower Spring River	02/10/05
OU5_SW_All_T	OU5_SW_LSR_T	QUA-05-SWPW-15_20050210	SURT_1061	Lower Spring River	02/10/05
OU5_SW_All_T	OU5_SW_LSR_T	SPRHY050210S	SPRHY10	Lower Spring River	02/10/05
OU5_SW_All_T	OU5_SW_LSR_T	SPRSE050210S	SPRSENP	Lower Spring River	02/10/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL21605WS	SRSL	Lower Spring River	02/16/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP21605WS	SRDP	Lower Spring River	02/16/05
OU5_SW_All_T	OU5_SW_LSR_T	371070_20050314	07188180	Lower Spring River	03/14/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP31705WS	SRDP	Lower Spring River	03/17/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL31705WS	SRSL	Lower Spring River	03/17/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL041805SW	SRSL	Lower Spring River	04/18/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP041805SW	SRDP	Lower Spring River	04/18/05
OU5_SW_All_T	OU5_SW_LSR_T	374258_20050510	07188180	Lower Spring River	05/10/05
OU5_SW_All_T	OU5_SW_LSR_T	374525_20050516	07188180	Lower Spring River	05/16/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP051705SW	SRDP	Lower Spring River	05/17/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL051705SW	SRSL	Lower Spring River	05/17/05
OU5_SW_All_T	OU5_SW_LSR_T	375307_20050525	07188180	Lower Spring River	05/25/05
OU5_SW_All_T	OU5_SW_LSR_T	376177_20050606	07188180	Lower Spring River	06/06/05
OU5_SW_All_T	OU5_SW_LSR_T	TCSW-074_20050610	TCSW074	Lower Spring River	06/10/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL061505SW	SRSL	Lower Spring River	06/15/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP061505SW	SRDP	Lower Spring River	06/15/05
OU5_SW_All_T	OU5_SW_LSR_T	377766_20050628	07188180	Lower Spring River	06/28/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL071305SW	SRSL	Lower Spring River	07/13/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP071305SW	SRDP	Lower Spring River	07/13/05
OU5_SW_All_T	OU5_SW_LSR_T	381301_20050817	07188180	Lower Spring River	08/17/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL082405SW	SRSL	Lower Spring River	08/24/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP082405SW	SRDP	Lower Spring River	08/24/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL092005SW	SRSL	Lower Spring River	09/20/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP092005SW	SRDP	Lower Spring River	09/20/05

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	SRSL101205SW	SRSL	Lower Spring River	10/12/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP101205SW	SRDP	Lower Spring River	10/12/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP113005SW	SRDP	Lower Spring River	11/30/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL113005SW	SRSL	Lower Spring River	11/30/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL122705SW	SRSL	Lower Spring River	12/27/05
OU5_SW_All_T	OU5_SW_LSR_T	SRDP122705SW	SRDP	Lower Spring River	12/27/05
OU5_SW_All_T	OU5_SW_LSR_T	SRSL011106SW	SRSL	Lower Spring River	01/11/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP011106SW	SRDP	Lower Spring River	01/11/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL021306SW	SRSL	Lower Spring River	02/13/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP021306SW	SRDP	Lower Spring River	02/13/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL031506SW	SRSL	Lower Spring River	03/15/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP031506SW	SRDP	Lower Spring River	03/15/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL041206SW	SRSL	Lower Spring River	04/12/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP041206SW	SRDP	Lower Spring River	04/12/06
OU5_SW_All_T	OU5_SW_LSR_T	07188180_WS_20060501	07188180	Lower Spring River	05/01/06
OU5_SW_All_T	OU5_SW_LSR_T	1000_20060502	SR-201	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1001_20060502	SR-203	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1023_20060502	SR-202	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1024_20060502	SR-BK03	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1075_20060502	SR-002	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1077_20060502	SR-003	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1078_20060502	SR-004	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1079_20060502	SR-005	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1100_20060502	SR-009	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1102_20060502	SR-008	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1209_20060502	SR-019	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1210_20060502	SR-018	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1211_20060502	SR-017	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1212_20060502	SR-016	Lower Spring River	05/02/06
OU5_SW_All_T	OU5_SW_LSR_T	1020_20060503	SR-303	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1022_20060503	SR-302	Lower Spring River	05/03/06

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	1025_20060503	SR-301	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1107_20060503	SR-101	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1108_20060503	SR-102	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1110_20060503	SR-103	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1111_20060503	SR-BK02-KAY	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1125_20060503	SR-006	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1126_20060503	SR-007	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1129_20060503	SR-BK02	Lower Spring River	05/03/06
OU5_SW_All_T	OU5_SW_LSR_T	1119_20060504	SR-012	Lower Spring River	05/04/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL051606SW	SRSL	Lower Spring River	05/16/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP051606SW	SRDP	Lower Spring River	05/16/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL061306SW	SRSL	Lower Spring River	06/13/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP061306SW	SRDP	Lower Spring River	06/13/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL072006SW	SRSL	Lower Spring River	07/20/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP072006SW	SRDP	Lower Spring River	07/20/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL081706SW	SRSL	Lower Spring River	08/17/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP081706SW	SRDP	Lower Spring River	08/17/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL091206SW	SRSL	Lower Spring River	09/12/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP091206SW	SRDP	Lower Spring River	09/12/06
OU5_SW_All_T	OU5_SW_LSR_T	07187995_WS_20060914	07187995	Lower Spring River	09/14/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL101806SW	SRSL	Lower Spring River	10/18/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP101806SW	SRDP	Lower Spring River	10/18/06
OU5_SW_All_T	OU5_SW_LSR_T	106SP1110806-S	106SP1	Lower Spring River	11/08/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL111606SW	SRSL	Lower Spring River	11/16/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP111606SW	SRDP	Lower Spring River	11/16/06
OU5_SW_All_T	OU5_SW_LSR_T	SRSL121406SW	SRSL	Lower Spring River	12/14/06
OU5_SW_All_T	OU5_SW_LSR_T	SRDP121406SW	SRDP	Lower Spring River	12/14/06
OU5_SW_All_T	OU5_SW_LSR_T	106SP1010807-S	106SP1	Lower Spring River	01/08/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL022107SW	SRSL	Lower Spring River	02/21/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP022107SW	SRDP	Lower Spring River	02/21/07
OU5_SW_All_T	OU5_SW_LSR_T	106SP1030507-S	106SP1	Lower Spring River	03/05/07

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	SRSL032107SW	SRSL	Lower Spring River	03/21/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP032107SW	SRDP	Lower Spring River	03/21/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL041907SW	SRSL	Lower Spring River	04/19/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP041907SW	SRDP	Lower Spring River	04/19/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL053107SW	SRSL	Lower Spring River	05/31/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP053107SW	SRDP	Lower Spring River	05/31/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL062707SW	SRSL	Lower Spring River	06/27/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP062707SW	SRDP	Lower Spring River	06/27/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL071907SW	SRSL	Lower Spring River	07/19/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP071907SW	SRDP	Lower Spring River	07/19/07
OU5_SW_All_T	OU5_SW_LSR_T	106SP1080607-S	106SP1	Lower Spring River	08/06/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL081607SW	SRSL	Lower Spring River	08/16/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP081607SW	SRDP	Lower Spring River	08/16/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL092007SW	SRSL	Lower Spring River	09/20/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP092007SW	SRDP	Lower Spring River	09/20/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL102407SW	SRSL	Lower Spring River	10/24/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP102407SW	SRDP	Lower Spring River	10/24/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL112607SW	SRSL	Lower Spring River	11/26/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP112607SW	SRDP	Lower Spring River	11/26/07
OU5_SW_All_T	OU5_SW_LSR_T	SRSL121907SW	SRSL	Lower Spring River	12/19/07
OU5_SW_All_T	OU5_SW_LSR_T	SRDP121907SW	SRDP	Lower Spring River	12/19/07
OU5_SW_All_T	OU5_SW_LSR_T	106SP1010708-S	106SP1	Lower Spring River	01/07/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL010908SW	SRSL	Lower Spring River	01/09/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP010908SW	SRDP	Lower Spring River	01/09/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL022008SW	SRSL	Lower Spring River	02/20/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP022008SW	SRDP	Lower Spring River	02/20/08
OU5_SW_All_T	OU5_SW_LSR_T	106SP1031008-S	106SP1	Lower Spring River	03/10/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL041508SW	SRSL	Lower Spring River	04/15/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP041508SW	SRDP	Lower Spring River	04/15/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL051408SW	SRSL	Lower Spring River	05/14/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP051408SW	SRDP	Lower Spring River	05/14/08

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	SRSL060508SW	SRSL	Lower Spring River	06/05/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP060508SW	SRDP	Lower Spring River	06/05/08
OU5_SW_All_T	OU5_SW_LSR_T	106SP1071608-S	106SP1	Lower Spring River	07/16/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL071608SW	SRSL	Lower Spring River	07/16/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP071608SW	SRDP	Lower Spring River	07/16/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL082108SW	SRSL	Lower Spring River	08/21/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP082108SW	SRDP	Lower Spring River	08/21/08
OU5_SW_All_T	OU5_SW_LSR_T	106SP1090808-S	106SP1	Lower Spring River	09/08/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL092408SW	SRSL	Lower Spring River	09/24/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP092408SW	SRDP	Lower Spring River	09/24/08
OU5_SW_All_T	OU5_SW_LSR_T	106SP1100708-S	106SP1	Lower Spring River	10/07/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL102008SW	SRSL	Lower Spring River	10/20/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP102008SW	SRDP	Lower Spring River	10/20/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL111708SW	SRSL	Lower Spring River	11/17/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP111708SW	SRDP	Lower Spring River	11/17/08
OU5_SW_All_T	OU5_SW_LSR_T	106SP1120808-S	106SP1	Lower Spring River	12/08/08
OU5_SW_All_T	OU5_SW_LSR_T	SRDP121908SW	SRDP	Lower Spring River	12/19/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL121908SW	SRSL	Lower Spring River	12/19/08
OU5_SW_All_T	OU5_SW_LSR_T	SRSL012209SW	SRSL	Lower Spring River	01/22/09
OU5_SW_All_T	OU5_SW_LSR_T	SRDP012209SW	SRDP	Lower Spring River	01/22/09
OU5_SW_All_T	OU5_SW_LSR_T	106SP1021709-S	106SP1	Lower Spring River	02/17/09
OU5_SW_All_T	OU5_SW_LSR_T	SRSL022609SW	SRSL	Lower Spring River	02/26/09
OU5_SW_All_T	OU5_SW_LSR_T	SRDP022609SW	SRDP	Lower Spring River	02/26/09
OU5_SW_All_T	OU5_SW_LSR_T	SRSL032009SW	SRSL	Lower Spring River	03/20/09
OU5_SW_All_T	OU5_SW_LSR_T	SRDP032009SW	SRDP	Lower Spring River	03/20/09
OU5_SW_All_T	OU5_SW_LSR_T	106SP1042109-S	106SP1	Lower Spring River	04/21/09
OU5_SW_All_T	OU5_SW_LSR_T	106SP1071309-S	106SP1	Lower Spring River	07/13/09
OU5_SW_All_T	OU5_SW_LSR_T	106SP1110909-S	106SP1	Lower Spring River	11/09/09
OU5_SW_All_T	OU5_SW_LSR_T	106SP1012510-S	106SP1	Lower Spring River	01/25/10
OU5_SW_All_T	OU5_SW_LSR_T	SRSL012510	SRSL	Lower Spring River	01/25/10
OU5_SW_All_T	OU5_SW_LSR_T	SRDP012510	SRDP	Lower Spring River	01/25/10

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	SRSL021810	SRSL	Lower Spring River	02/18/10
OU5_SW_All_T	OU5_SW_LSR_T	SRDP021810	SRDP	Lower Spring River	02/18/10
OU5_SW_All_T	OU5_SW_LSR_T	SRSL031810	SRSL	Lower Spring River	03/18/10
OU5_SW_All_T	OU5_SW_LSR_T	SRDP031810	SRDP	Lower Spring River	03/18/10
OU5_SW_All_T	OU5_SW_LSR_T	106SP1033110-S	106SP1	Lower Spring River	03/31/10
OU5_SW_All_T	OU5_SW_LSR_T	106SP1062310-S	106SP1	Lower Spring River	06/23/10
OU5_SW_All_T	OU5_SW_LSR_T	106SP1082310-S	106SP1	Lower Spring River	08/23/10
OU5_SW_All_T	OU5_SW_LSR_T	SP1101712S	SP1	Lower Spring River	10/17/12
OU5_SW_All_T	OU5_SW_LSR_T	SP2101712S	SP2	Lower Spring River	10/17/12
OU5_SW_All_T	OU5_SW_LSR_T	SP1111312S	SP1	Lower Spring River	11/13/12
OU5_SW_All_T	OU5_SW_LSR_T	SP2111312S	SP2	Lower Spring River	11/13/12
OU5_SW_All_T	OU5_SW_LSR_T	106SP1120412-S	106SP1	Lower Spring River	12/04/12
OU5_SW_All_T	OU5_SW_LSR_T	SP1120412S	SP1	Lower Spring River	12/04/12
OU5_SW_All_T	OU5_SW_LSR_T	SP2120412S	SP2	Lower Spring River	12/04/12
OU5_SW_All_T	OU5_SW_LSR_T	SP110913S	SP1	Lower Spring River	01/09/13
OU5_SW_All_T	OU5_SW_LSR_T	SP2010912S	SP2	Lower Spring River	01/09/13
OU5_SW_All_T	OU5_SW_LSR_T	SP1021513S	SP1	Lower Spring River	02/15/13
OU5_SW_All_T	OU5_SW_LSR_T	SP2021513S	SP2	Lower Spring River	02/15/13
OU5_SW_All_T	OU5_SW_LSR_T	SP1031113S	SP1	Lower Spring River	03/11/13
OU5_SW_All_T	OU5_SW_LSR_T	SP2031113S	SP2	Lower Spring River	03/11/13
OU5_SW_All_T	OU5_SW_LSR_T	SP1042313S	SP1	Lower Spring River	04/23/13
OU5_SW_All_T	OU5_SW_LSR_T	SP2042313S	SP2	Lower Spring River	04/23/13
OU5_SW_All_T	OU5_SW_LSR_T	106SP1042913-S	106SP1	Lower Spring River	04/29/13
OU5_SW_All_T	OU5_SW_LSR_T	SP1062813S	SP1	Lower Spring River	06/28/13
OU5_SW_All_T	OU5_SW_LSR_T	SP2062813S	SP2	Lower Spring River	06/28/13
OU5_SW_All_T	OU5_SW_LSR_T	SP1070913S	SP1	Lower Spring River	07/09/13
OU5_SW_All_T	OU5_SW_LSR_T	SP2070913S	SP2	Lower Spring River	07/09/13
OU5_SW_All_T	OU5_SW_LSR_T	106SP1072513-S	106SP1	Lower Spring River	07/25/13
OU5_SW_All_T	OU5_SW_LSR_T	SP1082713S	SP1	Lower Spring River	08/27/13
OU5_SW_All_T	OU5_SW_LSR_T	SP2082713S	SP2	Lower Spring River	08/27/13
OU5_SW_All_T	OU5_SW_LSR_T	SP1091813S	SP1	Lower Spring River	09/18/13

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	SP2091813S	SP2	Lower Spring River	09/18/13
OU5_SW_All_T	OU5_SW_LSR_T	SRBH011314	SRBH	Lower Spring River	01/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP011314	SRDP	Lower Spring River	01/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH021314	SRBH	Lower Spring River	02/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP021314	SRDP	Lower Spring River	02/13/14
OU5_SW_All_T	OU5_SW_LSR_T	106SP1021914-S	106SP1	Lower Spring River	02/19/14
OU5_SW_All_T	OU5_SW_LSR_T	106SR1031114-S	106SP1	Lower Spring River	03/11/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH031314	SRBH	Lower Spring River	03/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP031314	SRDP	Lower Spring River	03/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP040914	SRDP	Lower Spring River	04/09/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH040914	SRBH	Lower Spring River	04/09/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH051314	SRBH	Lower Spring River	05/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP051314	SRDP	Lower Spring River	05/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH061614	SRBH	Lower Spring River	06/16/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP061614	SRDP	Lower Spring River	06/16/14
OU5_SW_All_T	OU5_SW_LSR_T	106SP1061714-S	106SP1	Lower Spring River	06/17/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH071414	SRBH	Lower Spring River	07/14/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP071414	SRDP	Lower Spring River	07/14/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH081314	SRBH	Lower Spring River	08/13/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP081314	SRDP	Lower Spring River	08/13/14
OU5_SW_All_T	OU5_SW_LSR_T	106SP1082014-S	106SP1	Lower Spring River	08/20/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH091514	SRBH	Lower Spring River	09/15/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP091514	SRDP	Lower Spring River	09/15/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH101614	SRBH	Lower Spring River	10/16/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP101614	SRDP	Lower Spring River	10/16/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH111914	SRBH	Lower Spring River	11/19/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP111914	SRDP	Lower Spring River	11/19/14
OU5_SW_All_T	OU5_SW_LSR_T	106SP1120914-S	106SP1	Lower Spring River	12/09/14
OU5_SW_All_T	OU5_SW_LSR_T	SRBH121014	SRBH	Lower Spring River	12/10/14
OU5_SW_All_T	OU5_SW_LSR_T	SRDP121014	SRDP	Lower Spring River	12/10/14
OU5_SW_All_T	OU5_SW_LSR_T	106SP1033115-S	106SP1	Lower Spring River	03/31/15

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	SRBH042815	SRBH	Lower Spring River	04/28/15
OU5_SW_All_T	OU5_SW_LSR_T	SRDP042815	SRDP	Lower Spring River	04/28/15
OU5_SW_All_T	OU5_SW_LSR_T	SRBH051815	SRBH	Lower Spring River	05/18/15
OU5_SW_All_T	OU5_SW_LSR_T	SRDP051815	SRDP	Lower Spring River	05/18/15
OU5_SW_All_T	OU5_SW_LSR_T	SRBH061615	SRBH	Lower Spring River	06/16/15
OU5_SW_All_T	OU5_SW_LSR_T	SRDP061615	SRDP	Lower Spring River	06/16/15
OU5_SW_All_T	OU5_SW_LSR_T	SRBH071515	SRBH	Lower Spring River	07/15/15
OU5_SW_All_T	OU5_SW_LSR_T	SRDP071515	SRDP	Lower Spring River	07/15/15
OU5_SW_All_T	OU5_SW_LSR_T	106SP1072715-S	106SP1	Lower Spring River	07/27/15
OU5_SW_All_T	OU5_SW_LSR_T	SRBH081715	SRBH	Lower Spring River	08/17/15
OU5_SW_All_T	OU5_SW_LSR_T	SRDP081715	SRDP	Lower Spring River	08/17/15
OU5_SW_All_T	OU5_SW_LSR_T	SRBH091515	SRBH	Lower Spring River	09/15/15
OU5_SW_All_T	OU5_SW_LSR_T	SRDP091515	SRDP	Lower Spring River	09/15/15
OU5_SW_All_T	OU5_SW_LSR_T	SRBH011316	SRBH	Lower Spring River	01/13/16
OU5_SW_All_T	OU5_SW_LSR_T	SRDP011316	SRDP	Lower Spring River	01/13/16
OU5_SW_All_T	OU5_SW_LSR_T	SRBH021616	SRBH	Lower Spring River	02/16/16
OU5_SW_All_T	OU5_SW_LSR_T	SRDP021616	SRDP	Lower Spring River	02/16/16
OU5_SW_All_T	OU5_SW_LSR_T	SRBH032216	SRBH	Lower Spring River	03/22/16
OU5_SW_All_T	OU5_SW_LSR_T	SRDP032216	SRDP	Lower Spring River	03/22/16
OU5_SW_All_T	OU5_SW_LSR_T	SRBH041916	SRBH	Lower Spring River	04/19/16
OU5_SW_All_T	OU5_SW_LSR_T	SRDP041916	SRDP	Lower Spring River	04/19/16
OU5_SW_All_T	OU5_SW_LSR_T	SRBH051816	SRBH	Lower Spring River	05/18/16
OU5_SW_All_T	OU5_SW_LSR_T	SRDP051816	SRDP	Lower Spring River	05/18/16
OU5_SW_All_T	OU5_SW_LSR_T	SRBH061516	SRBH	Lower Spring River	06/15/16
OU5_SW_All_T	OU5_SW_LSR_T	SRDP061516	SRDP	Lower Spring River	06/15/16
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-FS-01	LS FS 01	Lower Spring River	07/25/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-MS-01	LS MS 01	Lower Spring River	09/18/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-MS-02	LS MS 02	Lower Spring River	09/21/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-MS-03	LS MS 03	Lower Spring River	09/25/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-FS-02	LS FS 02	Lower Spring River	09/26/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-MS-04	LS MS 04	Lower Spring River	09/28/17

Appendix C, Table 2b. Surface Water Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Data Grouping[b]	Sample ID	Location ID	Watershed	Sample Date
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-FS-03	LS FS 03	Lower Spring River	09/28/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-AR-01	LS AR 01	Lower Spring River	10/31/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-01	LS 01 - Kansas	Lower Spring River	11/01/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-02	LS 02 - Kansas	Lower Spring River	11/01/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-03	LS 03 - Kansas	Lower Spring River	11/01/17
OU5_SW_All_T	OU5_SW_LSR_T	LS-SW-MS-05	LS MS 05	Lower Spring River	11/01/17

Notes:

[a] All surface water samples (sitewide data grouping) were used to select COPCs in Tables 2.2a and 2.2b of Appendix B.

[b] EPCs were estimated separately for each watershed.

COPC = chemical of potential concern

EPC = exposure point concentration

HHRA = human health risk assessment

OU5 = Operable Unit 5

Appendix C, Table 2c. Biota Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a, b]	Data Grouping[c]	Data Grouping[a, b]	Data Grouping[c]	Sample ID	Location ID	Watershed	Sample Date	Biota Type	Sample Type	Species	Sample Fraction	Fish Species G/NG[d]	Bottom or Water Column Dweller
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-01-T	EC FS 01	Elm Creek	7/12/2017	Fish	Discrete	Common Carp	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-02-F	EC FS 01	Elm Creek	7/12/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-02-T	EC FS 01	Elm Creek	7/12/2017	Fish	Discrete	White Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-03-F	EC FS 02	Elm Creek	7/14/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-03-T	EC FS 02	Elm Creek	7/14/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-04-F	EC FS 02	Elm Creek	7/14/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-04-T	EC FS 02	Elm Creek	7/14/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-05-F	EC FS 03	Elm Creek	7/14/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-05-T	EC FS 03	Elm Creek	7/14/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-06-F	EC FS 03	Elm Creek	7/14/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-06-T	EC FS 03	Elm Creek	7/14/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-07-F	EC FS 04	Elm Creek	8/1/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-07-T	EC FS 04	Elm Creek	8/1/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-08-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-08-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-09-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-09-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-10-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-10-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-11-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-11-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-12-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-12-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-13-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-13-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-14-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-14-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-15-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-15-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-16-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-16-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-17-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-17-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-18-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Yellow Bullhead Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-18-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Yellow Bullhead Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-19-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Yellow Bullhead Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-19-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Yellow Bullhead Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-20-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Black Bullhead Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-20-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Black Bullhead Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-21-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Black Bullhead Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-21-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Black Bullhead Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_EC			EC-TS-FS-22-F	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Black Bullhead Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_EC		EC-TS-FS-22-T	EC FS 05	Elm Creek	8/3/2017	Fish	Discrete	Black Bullhead Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_EC			ODEQ-1246246-01	E 60 RD + E 65 RD	Elm Creek	8/1/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_EC			ODEQ-1246249-01	E 60 RD + E 65 RD	Elm Creek	8/1/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_EC			ODEQ-1246251-01	E 60 RD + E 65 RD	Elm Creek	8/1/2017	Fish	Discrete	Yellow Bullhead Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_TC			ODEQ-1245737-01	HWY 10 TO NEOSHO	Tar Creek	9/18/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_TC			ODEQ-1245739-01	HWY 10 TO NEOSHO	Tar Creek	9/18/2017	Fish	Discrete	White Bass	Fillet	G	Water Column

Appendix C, Table 2c. Biota Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a, b]	Data Grouping[c]	Data Grouping[a, b]	Data Grouping[c]	Sample ID	Location ID	Watershed	Sample Date	Biota Type	Sample Type	Species	Sample Fraction	Fish Species G/NG[d]	Bottom or Water Column Dweller
OU5_GFF_All	OU5_GFF_TC			ODEQ-1245741-01	HWY 10 TO NEOSHO	Tar Creek	9/18/2017	Fish	Discrete	Spotted Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_TC			ODEQ-1245745-01	HWY 10 TO NEOSHO	Tar Creek	9/18/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_TC			ODEQ-1246206-01	HWY 10 TO NEOSHO	Tar Creek	9/18/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_TC			ODEQ-1249240-01	ROCKDALE-MIKINLEY 10	Tar Creek	8/8/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_TC			ODEQ-1249242-01	ROCKDALE-MIKINLEY 10	Tar Creek	8/8/2017	Fish	Discrete	Black Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-01-T	TC FS 01	Tar Creek	7/10/2017	Fish	Discrete	Smallmouth Buffalo	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-02-F	TC FS 01	Tar Creek	7/10/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-02-T	TC FS 01	Tar Creek	7/10/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-03-F	TC FS 02	Tar Creek	7/12/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-03-T	TC FS 02	Tar Creek	7/12/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-04-F	TC FS 02	Tar Creek	7/12/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-04-T	TC FS 02	Tar Creek	7/12/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-05-F	TC FS 03	Tar Creek	7/12/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-05-T	TC FS 03	Tar Creek	7/12/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-06-F	TC FS 03	Tar Creek	7/12/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-06-T	TC FS 03	Tar Creek	7/12/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-07-F	TC FS 04	Tar Creek	8/9/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-07-T	TC FS 04	Tar Creek	8/9/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-08-F	TC FS 04	Tar Creek	8/9/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-08-T	TC FS 04	Tar Creek	8/9/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-09-F	TC FS 04	Tar Creek	8/9/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-09-T	TC FS 04	Tar Creek	8/9/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-10-F	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-10-T	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-11-F	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-11-T	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-12-F	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-12-T	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-13-F	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-13-T	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-14-F	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-14-T	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_TC			TC-TS-FS-15-F	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_TC		TC-TS-FS-15-T	TC FS 05	Tar Creek	8/9/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-01	PADDLEFISH 01	Neosho River	4/15/2017	Fish	Discrete	Paddlefish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-01-T	NR FS 01	Neosho River	7/25/2017	Fish	Discrete	Smallmouth Buffalo	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-02	PADDLEFISH 02	Neosho River	4/20/2017	Fish	Discrete	Paddlefish	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-02-F	NR FS 02	Neosho River	7/25/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-02-T	NR FS 02	Neosho River	7/25/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-03	PADDLEFISH 03	Neosho River	4/20/2017	Fish	Discrete	Paddlefish	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-03-F	NR FS 02	Neosho River	9/19/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-03-T	NR FS 02	Neosho River	9/19/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-04	PADDLEFISH 04	Neosho River	4/20/2017	Fish	Discrete	Paddlefish	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-04-F	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	Blue Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-04-T	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	Blue Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-05	PADDLEFISH 05	Neosho River	4/20/2017	Fish	Discrete	Paddlefish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-05-T	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	Common Carp	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-06	PADDLEFISH 06	Neosho River	4/20/2017	Fish	Discrete	Paddlefish	Fillet	G	Water Column

Appendix C, Table 2c. Biota Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a, b]	Data Grouping[c]	Data Grouping[a, b]	Data Grouping[c]	Sample ID	Location ID	Watershed	Sample Date	Biota Type	Sample Type	Species	Sample Fraction	Fish Species G/NG[d]	Bottom or Water Column Dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-06-T	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	Smallmouth Buffalo	Total Estimated	NG	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-07-T	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	Smallmouth Buffalo	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-08-F	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-08-T	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	White Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-09-F	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-09-T	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	White Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-10-F	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-10-T	NR FS 01	Neosho River	9/19/2017	Fish	Discrete	White Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-11-F	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	White Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-11-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	White Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-12-F	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Blue Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-12-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Blue Catfish	Total Estimated	G	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-13-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Common Carp	Total Estimated	NG	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-14-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Smallmouth Buffalo	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-15-F	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Flathead Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-15-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Flathead Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-16-F	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-16-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-17-F	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-17-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	White Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-18-F	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Black Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-18-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Black Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			NR-TS-FS-18-F	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Black Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_NR		NR-TS-FS-18-T	NR FS 03	Neosho River	9/21/2017	Fish	Discrete	Black Crappie	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245782-01	NEAR ELM CREEK CONFL	Neosho River	9/19/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245784-01	NEAR ELM CREEK CONFL	Neosho River	9/19/2017	Fish	Discrete	Blue Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245786-01	NEAR ELM CREEK CONFL	Neosho River	9/19/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245793-01	RIVERVIEW PARK	Neosho River	9/20/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245795-01	RIVERVIEW PARK	Neosho River	9/20/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245802-01	AT CONNORS BRIDGE	Neosho River	9/21/2017	Fish	Discrete	White Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245804-01	AT CONNORS BRIDGE	Neosho River	9/21/2017	Fish	Discrete	Blue Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245806-01	AT CONNORS BRIDGE	Neosho River	9/21/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_NR			ODEQ-1245808-01	AT CONNORS BRIDGE	Neosho River	9/21/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_BC			BC-TS-FS-01-F	BC FS 01	Beaver Creek	7/18/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_BC		BC-TS-FS-01-T	BC FS 01	Beaver Creek	7/18/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_FTE_All		OU5_FTE_BC		BC-TS-FS-02-T	BC FS 01	Beaver Creek	7/18/2017	Fish	Discrete	Freshwater Drum	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_BC			BC-TS-FS-03-F	BC FS 02	Beaver Creek	7/17/2017	Fish	Discrete	Smallmouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_BC		BC-TS-FS-03-T	BC FS 02	Beaver Creek	7/17/2017	Fish	Discrete	Smallmouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_BC			BC-TS-FS-04-F	BC FS 02	Beaver Creek	7/17/2017	Fish	Discrete	Green Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_BC		BC-TS-FS-04-T	BC FS 02	Beaver Creek	7/17/2017	Fish	Discrete	Green Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_LC			LC-TS-FS-01-F	LC FS 01	Lost Creek	7/6/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LC		LC-TS-FS-01-T	LC FS 01	Lost Creek	7/6/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_LC			LC-TS-FS-02-F	LC FS 01	Lost Creek	7/6/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LC		LC-TS-FS-02-T	LC FS 01	Lost Creek	7/6/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_LC			LC-TS-FS-03-F	LC FS 02	Lost Creek	7/7/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_LC		LC-TS-FS-03-T	LC FS 02	Lost Creek	7/7/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_GFF_All	OU5_GFF_LC			LC-TS-FS-04-F	LC FS 02	Lost Creek	7/7/2017	Fish	Discrete	Longear Sunfish	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LC		LC-TS-FS-04-T	LC FS 02	Lost Creek	7/7/2017	Fish	Discrete	Longear Sunfish	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_LC			LC-TS-FS-05-F	LC FS 03	Lost Creek	7/7/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LC		LC-TS-FS-05-T	LC FS 03	Lost Creek	7/7/2017	Fish	Discrete	Bluegill	Total Estimated	G	Water Column

Appendix C, Table 2c. Biota Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a, b]	Data Grouping[c]	Data Grouping[a, b]	Data Grouping[c]	Sample ID	Location ID	Watershed	Sample Date	Biota Type	Sample Type	Species	Sample Fraction	Fish Species G/NG[d]	Bottom or Water Column Dweller
OU5_FTE_All		OU5_FTE_LC		LC-TS-FS-06-T	LC FS 03	Lost Creek	7/10/2017	Fish	Discrete	Freshwater Drum	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_LC			LC-TS-FS-07-F	LC FS 03	Lost Creek	7/19/2017	Fish	Discrete	Smallmouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LC		LC-TS-FS-07-T	LC FS 03	Lost Creek	7/19/2017	Fish	Discrete	Smallmouth Bass	Total Estimated	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-01-T	LS FS 01	Lower Spring River	7/25/2017	Fish	Discrete	Freshwater Drum	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			LS-TS-FS-02-F	LS FS 01	Lower Spring River	7/25/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-02-T	LS FS 01	Lower Spring River	7/25/2017	Fish	Discrete	Largemouth Bass	Total Estimated	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-03-T	LS FS 02	Lower Spring River	9/26/2017	Fish	Discrete	Smallmouth Buffalo	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			LS-TS-FS-04-F	LS FS 02	Lower Spring River	9/26/2017	Fish	Discrete	White Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-04-T	LS FS 02	Lower Spring River	9/26/2017	Fish	Discrete	White Bass	Total Estimated	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-05-T	LS FS 02	Lower Spring River	9/26/2017	Fish	Discrete	Freshwater Drum	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			LS-TS-FS-06-F	LS FS 02	Lower Spring River	9/26/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-06-T	LS FS 02	Lower Spring River	9/26/2017	Fish	Discrete	White Crappie	Total Estimated	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-07-T	LS FS 02	Lower Spring River	9/26/2017	Fish	Discrete	Common Carp	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			LS-TS-FS-08-F	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-08-T	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Channel Catfish	Total Estimated	G	Bottom dweller
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-09-T	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Red Horse	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			LS-TS-FS-10-F	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	White Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-10-T	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	White Bass	Total Estimated	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			LS-TS-FS-11-F	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Spotted Bass	Fillet	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-11-T	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Spotted Bass	Total Estimated	G	Water Column
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-12-T	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Smallmouth Buffalo	Total Estimated	NG	Bottom dweller
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-13-T	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Freshwater Drum	Total Estimated	NG	Bottom dweller
OU5_FTE_All		OU5_FTE_LSR		LS-TS-FS-14-T	LS FS 03	Lower Spring River	9/29/2017	Fish	Discrete	Common Carp	Total Estimated	NG	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248386-01	DEVILS PROMENADE	Lower Spring River	9/29/2017	Fish	Discrete	Spotted Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248388-01	DEVILS PROMENADE	Lower Spring River	9/29/2017	Fish	Discrete	White Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248392-01	DEVILS PROMENADE	Lower Spring River	9/29/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248394-01	DEVILS PROMENADE	Lower Spring River	9/29/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248401-01	HWY10 MOCCASIN BEND	Lower Spring River	9/28/2017	Fish	Discrete	Spotted Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248403-01	HWY10 MOCCASIN BEND	Lower Spring River	9/28/2017	Fish	Discrete	White Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248405-01	HWY10 MOCCASIN BEND	Lower Spring River	9/28/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248407-01	HWY10 MOCCASIN BEND	Lower Spring River	9/28/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248409-01	HWY10 MOCCASIN BEND	Lower Spring River	9/28/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248416-01	UPSTREAM TWIN BRIDGE	Lower Spring River	9/26/2017	Fish	Discrete	Channel Catfish	Fillet	G	Bottom dweller
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248418-01	UPSTREAM TWIN BRIDGE	Lower Spring River	9/26/2017	Fish	Discrete	White Crappie	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248420-01	UPSTREAM TWIN BRIDGE	Lower Spring River	9/26/2017	Fish	Discrete	White Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248422-01	UPSTREAM TWIN BRIDGE	Lower Spring River	9/26/2017	Fish	Discrete	Largemouth Bass	Fillet	G	Water Column
OU5_GFF_All	OU5_GFF_LSR			ODEQ-1248424-01	UPSTREAM TWIN BRIDGE	Lower Spring River	9/26/2017	Fish	Discrete	Bluegill	Fillet	G	Water Column
OU5_SF_All	OU5_SF_NR			NR-TS-MS-02	NR MS 02	Neosho River	10/30/2017	Shellfish	Composite	Mussel			
OU5_SF_All	OU5_SF_LSR			BRSH137875CF1	BRSH1_KDHE	Spring River	9/11/2003	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			BRSH137875CF2	BRSH1_KDHE	Spring River	9/11/2003	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			BRSH137875CF3	BRSH1_KDHE	Spring River	9/11/2003	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			SPRNG637875CF1	SPRNG6_KDHE	Spring River	9/11/2003	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			SPRNG637875CF2	SPRNG6_KDHE	Spring River	9/11/2003	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			SPRNG637875CF3	SPRNG6_KDHE	Spring River	9/11/2003	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			SPRNG638614CF1	SPRNG6_KDHE	Spring River	9/19/2005	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			SPRNG638614CF2	SPRNG6_KDHE	Spring River	9/19/2005	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			SPRNG638614CF3	SPRNG6_KDHE	Spring River	9/19/2005	Shellfish	Composite	Corbicula fluminea			
OU5_SF_All	OU5_SF_LSR			SPRNG638614LC	SPRNG6_KDHE	Spring River	9/19/2005	Shellfish	Discrete	Lampsilis cardium			

Appendix C, Table 2c. Biota Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a, b]	Data Grouping[c]	Data Grouping[a, b]	Data Grouping[c]	Sample ID	Location ID	Watershed	Sample Date	Biota Type	Sample Type	Species	Sample Fraction	Fish Species G/NG[d]	Bottom or Water Column Dweller
OU5_SF_All	OU5_SF_LSR			SPRNG638614OR	SPRNG6_KDHE	Spring River	9/19/2005	Shellfish	Discrete	Obliquaria reflexa			
OU5_SF_All	OU5_SF_LSR			SPRNG638618PG1	SPRNG6_KDHE	Spring River	9/23/2005	Shellfish	Discrete	Pyganodon grandis			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-01	LS MS 01	Lower Spring River	9/18/2017	Shellfish	Discrete	Asian Clam			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-02	LS MS 02	Lower Spring River	9/21/2017	Shellfish	Discrete	Asian Clam			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-03	LS MS 03	Lower Spring River	9/25/2017	Shellfish	Discrete	Asian Clam			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-04	LS MS 04	Lower Spring River	9/28/2017	Shellfish	Discrete	Asian Clam			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-06	LS MS 04	Lower Spring River	10/30/2017	Shellfish	Composite	Mussel			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-07	LS MS 01	Lower Spring River	10/30/2017	Shellfish	Composite	Mussel			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-08	LS MS 03	Lower Spring River	10/31/2017	Shellfish	Composite	Mussel			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-09	LS MS 02	Lower Spring River	11/1/2017	Shellfish	Composite	Mussel			
OU5_SF_All	OU5_SF_LSR			LS-TS-MS-05	LS MS 05	Lower Spring River	11/1/2017	Shellfish	Composite	Mussel			
OU5_AP_All	OU5_AP_EC			EC-1-20_2011	EC-1	Elm Creek	1/1/2011	Plant	Discrete	Duckweed			
OU5_AP_All	OU5_AP_EC	OU5_APS_All	OU5_APS_EC	EC-TS-AR-01-L	EC AR 01	Elm Creek	10/31/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_EC	OU5_APS_All	OU5_APS_EC	EC-TS-AR-01-R	EC AR 01	Elm Creek	10/31/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_TC			TC-1-01_2011	TC-1	Tar Creek	1/1/2011	Plant	Discrete	Duckweed			
OU5_AP_All	OU5_AP_TC	OU5_APS_All	OU5_APS_TC	TC-TS-AR-01-L	TC AR 01	Tar Creek	11/1/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_TC	OU5_APS_All	OU5_APS_TC	TC-TS-AR-01-R	TC AR 01	Tar Creek	11/1/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_NR			NR-TS-DW-01	NR DW 01	Neosho River	10/30/2017	Plant	Composite	Duckweed			
OU5_AP_All	OU5_AP_LC			LC-2-11_2011	LC-2	Lost Creek	1/1/2011	Plant	Discrete	Duckweed			
OU5_AP_All	OU5_AP_LC	OU5_APS_All	OU5_APS_LC	LC-2-15_2011	LC-2	Lost Creek	1/1/2011	Plant	Discrete	Arrowhead			
OU5_AP_All	OU5_AP_LC	OU5_APS_All	OU5_APS_LC	LC-3-01_2011	LC-3	Lost Creek	1/1/2011	Plant	Discrete	Arrowhead			
OU5_AP_All	OU5_AP_LC			LC-TS-DW-01	LC DW 01	Lost Creek	7/26/2017	Plant	Composite	Duckweed			
OU5_AP_All	OU5_AP_LC	OU5_APS_All	OU5_APS_LC	LC-3-01_2011	LC-3	Lost Creek	1/1/2011	Plant	Discrete	Arrowhead			
OU5_AP_All	OU5_AP_LC			LC-TS-DW-01	LC DW 01	Lost Creek	7/26/2017	Plant	Composite	Duckweed			
OU5_AP_All	OU5_AP_LC			LC-TS-DW-02	LC DW 02	Lost Creek	7/26/2017	Plant	Composite	Duckweed			
OU5_AP_All	OU5_AP_LC	OU5_APS_All	OU5_APS_LC	LC-TS-AR-01-T	LC AR 01	Lost Creek	10/31/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_LC	OU5_APS_All	OU5_APS_LC	LC-TS-AR-01-L	LC AR 01	Lost Creek	10/31/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_LC	OU5_APS_All	OU5_APS_LC	LC-TS-AR-01-R	LC AR 01	Lost Creek	10/31/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_LSR	OU5_APS_All	OU5_APS_LSR	LS-TS-AR-01-L	LS AR 01	Lower Spring River	10/31/2017	Plant	Composite	Arrowhead			
OU5_AP_All	OU5_AP_LSR	OU5_APS_All	OU5_APS_LSR	LS-TS-AR-01-R	LS AR 01	Lower Spring River	10/31/2017	Plant	Composite	Arrowhead			
OU5_AR_All	OU5_AR_TC			TC-TS-FG-01	TC FG 01	Tar Creek	7/13/2017	Amphibian	Composite	Bull Frog			
OU5_AR_All	OU5_AR_TC			TC-TS-FG-02	TC FG 02	Tar Creek	7/21/2017	Amphibian	Discrete	Bull Frog			
OU5_AR_All	OU5_AR_NR			NR-TS-FG-03	NR FG 03	Neosho River	7/12/2017	Amphibian	Discrete	Bull Frog			
OU5_AR_All	OU5_AR_NR			NR-TS-FG-04	NR FG 04	Neosho River	7/17/2017	Amphibian	Composite	Bull Frog			
OU5_AR_All	OU5_AR_NR			NR-TS-FG-01	NR FG 01	Neosho River	8/24/2017	Amphibian	Discrete	Bull Frog			
OU5_AR_All	OU5_AR_NR			NR-TS-FG-02	NR FG 02	Neosho River	8/24/2017	Amphibian	Discrete	Bull Frog			
OU5_AR_All	OU5_AR_BC			BC-TS-FG-01	BC FG 01	Beaver Creek	8/21/2017	Amphibian	Composite	Bull Frog			
OU5_AR_All	OU5_AR_BC			BC-TS-FG-02	BC FG 02	Beaver Creek	8/21/2017	Amphibian	Discrete	Bull Frog			
OU5_AR_All	OU5_AR_BC			BC-TS-FG-03	BC FG 03	Beaver Creek	8/21/2017	Amphibian	Composite	Bull Frog			
OU5_AR_All	OU5_AR_BC			BC-TS-FG-06	BC FG 04	Beaver Creek	8/24/2017	Amphibian	Discrete	Bull Frog			
OU5_AR_All	OU5_AR_LC			LC-TS-FG-01	LC FG 01	Lost Creek	7/19/2017	Amphibian	Composite	Bull Frog			
OU5_AR_All	OU5_AR_LSR			LS-TS-FG-02	LS FG 02	Lower Spring River	7/24/2017	Amphibian	Composite	Bull Frog			
OU5_AR_All	OU5_AR_LSR			LS-TS-FG-03	LS FG 03	Lower Spring River	7/24/2017	Amphibian	Composite	Bull Frog			
OU5_AR_All	OU5_AR_LSR			LS-TS-FG-01	LS FG 01	Lower Spring River	7/24/2017	Amphibian	Discrete	Bull Frog			
OU5_SAM_All	OU5_SAM_EC			EC-TS-RC-04	EC RC 04	Elm Creek	8/23/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_TC			TC-TS-RC-02	TC RC 02	Tar Creek	8/31/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_TC			TC-TS-RC-03	TC RC 03	Tar Creek	8/31/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_TC			TC-TS-RC-01A	TC RC 01	Tar Creek	8/31/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_NR			NR-TS-RC-04	NR RC 04	Neosho River	7/12/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_NR			NR-TS-RC-06	NR RC 06	Neosho River	7/12/2017	Semi-aquatic mammals	Discrete	Raccoon			

Appendix C, Table 2c. Biota Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a, b]	Data Grouping[c]	Data Grouping[a, b]	Data Grouping[c]	Sample ID	Location ID	Watershed	Sample Date	Biota Type	Sample Type	Species	Sample Fraction	Fish Species G/NG[d]	Bottom or Water Column Dweller
OU5_SAM_All	OU5_SAM_NR			NR-TS-RC-05	NR RC 05	Neosho River	7/13/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_NR			NR-TS-RC-01	NR RC 01	Neosho River	8/28/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_NR			NR-TS-RC-03	NR RC 03	Neosho River	10/3/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_NR			NR-TS-RC-02	NR RC 02	Neosho River	10/31/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_BC			BC-TS-RC-01	BC RC 01	Beaver Creek	8/25/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_BC			BC-TS-RC-02	BC RC 02	Beaver Creek	8/25/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_BC			BC-TS-RC-03	BC RC 03	Beaver Creek	10/18/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_LC			LC-TS-RC-01	LC RC 01	Lost Creek	8/22/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_LC			LC-TS-RC-02	LC RC 02	Lost Creek	8/28/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_LC			LC-TS-RC-03	LC RC 03	Lost Creek	10/25/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_LSR			LS-TS-RC-01	LS RC 01	Lower Spring River	8/16/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_LSR			LS-TS-RC-02	LS RC 02	Lower Spring River	8/28/2017	Semi-aquatic mammals	Discrete	Raccoon			
OU5_SAM_All	OU5_SAM_LSR			LS-TS-RC-03	LS RC 03	Lower Spring River	8/29/2017	Semi-aquatic mammals	Discrete	Raccoon			

Notes:

[a] All (sitewide) data groupings for each biota type were used to select COPCs in Tables 2.3 through 2.9 of Appendix B.

[b] EPCs were estimated using the all (sitewide) data groupings for each biota type.

[c] Evaluation of watershed-specific datasets is presented in Appendix F5.

[d] Fish species: G = game species; NG = non-game species.

COPC = chemical of potential concern

EPC = exposure point concentration

HHRA = human health risk assessment

OU5 = Operable Unit 5

Appendix D
ProUCL Output

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:07:05 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	4.1	Mean	5402
Maximum	10800	Median	5402

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Aluminum (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	3.02	Mean	6.51
Maximum	10	Median	6.51

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Arsenic (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Barium (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	158	Mean	294
Maximum	430	Median	294

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Barium (mg/kg) was not processed!

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	0.994	Mean	1.497
Maximum	2	Median	1.497

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Beryllium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	3	Mean	25.89
Maximum	80.3	Median	20.1
SD	22.66	Std. Error of Mean	7.552
Coefficient of Variation	0.875	Skewness	1.975

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.796	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.264	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	39.93	95% Adjusted-CLT UCL (Chen-1995)	43.62
		95% Modified-t UCL (Johnson-1978)	40.76

Gamma GOF Test

A-D Test Statistic	0.291	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.733	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.168	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.283	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	1.674	k star (bias corrected MLE)	1.19
Theta hat (MLE)	15.47	Theta star (bias corrected MLE)	21.76
nu hat (MLE)	30.12	nu star (bias corrected)	21.42
MLE Mean (bias corrected)	25.89	MLE Sd (bias corrected)	23.73
		Approximate Chi Square Value (0.05)	11.9
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	10.44

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	46.59	95% Adjusted Gamma UCL (use when n<50)	53.12

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.203	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.099	Mean of logged Data	2.926
Maximum of Logged Data	4.386	SD of logged Data	0.919

Assuming Lognormal Distribution

95% H-UCL	77.03	90% Chebyshev (MVUE) UCL	52.28
95% Chebyshev (MVUE) UCL	63.82	97.5% Chebyshev (MVUE) UCL	79.84
99% Chebyshev (MVUE) UCL	111.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	38.31	95% Jackknife UCL	39.93
95% Standard Bootstrap UCL	37.83	95% Bootstrap-t UCL	51.49
95% Hall's Bootstrap UCL	94.66	95% Percentile Bootstrap UCL	38.72
95% BCA Bootstrap UCL	43.88		
90% Chebyshev(Mean, Sd) UCL	48.54	95% Chebyshev(Mean, Sd) UCL	58.81
97.5% Chebyshev(Mean, Sd) UCL	73.05	99% Chebyshev(Mean, Sd) UCL	101

Suggested UCL to Use

95% Student's-t UCL 39.93

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chromium (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	20.6	Mean	37.8
Maximum	55	Median	37.8

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Chromium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	8.42	Mean	10.71
Maximum	13	Median	10.71

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Cobalt (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Copper (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	13	Mean	54.15
Maximum	95.3	Median	54.15

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Copper (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Iron (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	3.1	Mean	13402
Maximum	26800	Median	13402

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Iron (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Lead (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	73.2	Mean	367.2
Maximum	1200	Median	267
SD	348.2	Std. Error of Mean	116.1
Coefficient of Variation	0.948	Skewness	2.057

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.757	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.272	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	583.1	95% Adjusted-CLT UCL (Chen-1995)	643.2
		95% Modified-t UCL (Johnson-1978)	596.4

Gamma GOF Test

A-D Test Statistic	0.389	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.732	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.203	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.283	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	1.741	k star (bias corrected MLE)	1.235
Theta hat (MLE)	211	Theta star (bias corrected MLE)	297.5
nu hat (MLE)	31.33	nu star (bias corrected)	22.22
MLE Mean (bias corrected)	367.2	MLE Sd (bias corrected)	330.5
		Approximate Chi Square Value (0.05)	12.5
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	11

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	652.6	95% Adjusted Gamma UCL (use when n<50)	742

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.152	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.293	Mean of logged Data	5.592
Maximum of Logged Data	7.09	SD of logged Data	0.817

Assuming Lognormal Distribution

95% H-UCL	852	90% Chebyshev (MVUE) UCL	658.8
95% Chebyshev (MVUE) UCL	795.1	97.5% Chebyshev (MVUE) UCL	984.3
99% Chebyshev (MVUE) UCL	1356		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	558.2	95% Jackknife UCL	583.1
95% Standard Bootstrap UCL	544.4	95% Bootstrap-t UCL	987.1
95% Hall's Bootstrap UCL	1481	95% Percentile Bootstrap UCL	563.8
95% BCA Bootstrap UCL	635.5		
90% Chebyshev(Mean, Sd) UCL	715.5	95% Chebyshev(Mean, Sd) UCL	873.2
97.5% Chebyshev(Mean, Sd) UCL	1092	99% Chebyshev(Mean, Sd) UCL	1522

Suggested UCL to Use

95% Student's-t UCL 583.1

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lithium (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	25	Mean	25
Maximum	25	Median	25

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Lithium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Manganese (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	213	Mean	366.5
Maximum	520	Median	366.5

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Manganese (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Mercury (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	0.07	Mean	0.07
Maximum	0.07	Median	0.07

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Mercury (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nickel (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	23.5	Mean	24.25
Maximum	25	Median	24.25

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Nickel (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Phosphorus (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	530	Mean	530
Maximum	530	Median	530

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Phosphorus (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Selenium (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	1
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Selenium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Strontium (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	75	Mean	75
Maximum	75	Median	75

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Strontium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	32.7	Mean	52.35
Maximum	72	Median	52.35

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Vanadium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Zinc (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	773	Mean	13963
Maximum	109000	Median	1740
SD	35651	Std. Error of Mean	11884
Coefficient of Variation	2.553	Skewness	2.996

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.413	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.499	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	36061	95% Adjusted-CLT UCL (Chen-1995)	46191
		95% Modified-t UCL (Johnson-1978)	38039

Gamma GOF Test

A-D Test Statistic	2.043	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.785	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.44	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.297	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.421	k star (bias corrected MLE)	0.354
Theta hat (MLE)	33198	Theta star (bias corrected MLE)	39391
nu hat (MLE)	7.57	nu star (bias corrected)	6.38
MLE Mean (bias corrected)	13963	MLE Sd (bias corrected)	23452
		Approximate Chi Square Value (0.05)	1.837
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	1.37

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	48490	95% Adjusted Gamma UCL (use when n<50)	65024

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.692	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.302	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.274	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.65	Mean of logged Data	7.992
Maximum of Logged Data	11.6	SD of logged Data	1.428

Assuming Lognormal Distribution

95% H-UCL	70315	90% Chebyshev (MVUE) UCL	16927
95% Chebyshev (MVUE) UCL	21501	97.5% Chebyshev (MVUE) UCL	27849
99% Chebyshev (MVUE) UCL	40318		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	33510	95% Jackknife UCL	36061
95% Standard Bootstrap UCL	32298	95% Bootstrap-t UCL	730190
95% Hall's Bootstrap UCL	395791	95% Percentile Bootstrap UCL	37670
95% BCA Bootstrap UCL	49641		
90% Chebyshev(Mean, Sd) UCL	49614	95% Chebyshev(Mean, Sd) UCL	65763
97.5% Chebyshev(Mean, Sd) UCL	88177	99% Chebyshev(Mean, Sd) UCL	132204

Appendix D, Table 1. ProUCL Output - Elm Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Hall's Bootstrap UCL 395791

Recommended UCL exceeds the maximum observation

In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:24:37 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	70
		Number of Missing Observations	0
Minimum	3.2	Mean	10384
Maximum	26700	Median	10700
SD	7212	Std. Error of Mean	786.9
Coefficient of Variation	0.695	Skewness	0.0187

Normal GOF Test

Shapiro Wilk Test Statistic	0.926	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	6.3418E-5	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.11	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	11693	95% Adjusted-CLT UCL (Chen-1995)	11680
		95% Modified-t UCL (Johnson-1978)	11694

Gamma GOF Test

A-D Test Statistic	8.55	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.812	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.228	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.103	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.563	k star (bias corrected MLE)	0.55
Theta hat (MLE)	18458	Theta star (bias corrected MLE)	18866
nu hat (MLE)	94.52	nu star (bias corrected)	92.47
MLE Mean (bias corrected)	10384	MLE Sd (bias corrected)	13997
		Approximate Chi Square Value (0.05)	71.3
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	70.97

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	13469	95% Adjusted Gamma UCL (use when n<50)	13530

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.623	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.289	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0968	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.163	Mean of logged Data	8.139
Maximum of Logged Data	10.19	SD of logged Data	2.715

Assuming Lognormal Distribution

95% H-UCL	492417	90% Chebyshev (MVUE) UCL	289831
95% Chebyshev (MVUE) UCL	369658	97.5% Chebyshev (MVUE) UCL	480456
99% Chebyshev (MVUE) UCL	698096		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	11679	95% Jackknife UCL	11693
95% Standard Bootstrap UCL	11654	95% Bootstrap-t UCL	11697
95% Hall's Bootstrap UCL	11683	95% Percentile Bootstrap UCL	11723
95% BCA Bootstrap UCL	11687		
90% Chebyshev(Mean, Sd) UCL	12745	95% Chebyshev(Mean, Sd) UCL	13815
97.5% Chebyshev(Mean, Sd) UCL	15299	99% Chebyshev(Mean, Sd) UCL	18214

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 13815

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	73	Number of Distinct Observations	18
Number of Detects	35	Number of Non-Detects	38
Number of Distinct Detects	8	Number of Distinct Non-Detects	10
Minimum Detect	0.2	Minimum Non-Detect	1
Maximum Detect	749	Maximum Non-Detect	14.6
Variance Detects	23567	Percent Non-Detects	52.05%
Mean Detects	37.07	SD Detects	153.5
Median Detects	0.3	CV Detects	4.141
Skewness Detects	4.174	Kurtosis Detects	16.9
Mean of Logged Detects	-0.66	SD of Logged Detects	1.797

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.263	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.536	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.148	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	17.96	KM Standard Error of Mean	12.63
KM SD	106.4	95% KM (BCA) UCL	42.92
95% KM (t) UCL	39	95% KM (Percentile Bootstrap) UCL	40
95% KM (z) UCL	38.73	95% KM Bootstrap t UCL	13764
90% KM Chebyshev UCL	55.85	95% KM Chebyshev UCL	73.01
97.5% KM Chebyshev UCL	96.83	99% KM Chebyshev UCL	143.6

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	12.28	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.93	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.546	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.166	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.176	k star (bias corrected MLE)	0.18
Theta hat (MLE)	211	Theta star (bias corrected MLE)	206.3
nu hat (MLE)	12.3	nu star (bias corrected)	12.58
Mean (detects)	37.07		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	26.37
Maximum	749	Median	0.3
SD	110.9	CV	4.207
k hat (MLE)	0.152	k star (bias corrected MLE)	0.155
Theta hat (MLE)	173.9	Theta star (bias corrected MLE)	170.6
nu hat (MLE)	22.14	nu star (bias corrected)	22.56
Adjusted Level of Significance (β)	0.0467		
Approximate Chi Square Value (22.56, α)	12.76	Adjusted Chi Square Value (22.56, β)	12.61
95% Gamma Approximate UCL (use when n>=50)	46.63	95% Gamma Adjusted UCL (use when n<50)	47.18

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	17.96	SD (KM)	106.4
Variance (KM)	11313	SE of Mean (KM)	12.63
k hat (KM)	0.0285	k star (KM)	0.0365
nu hat (KM)	4.161	nu star (KM)	5.323
theta hat (KM)	630.1	theta star (KM)	492.5
80% gamma percentile (KM)	0.627	90% gamma percentile (KM)	16.34
95% gamma percentile (KM)	81.29	99% gamma percentile (KM)	437.7

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.32, α)	1.304	Adjusted Chi Square Value (5.32, β)	1.265
95% Gamma Approximate KM-UCL (use when n>=50)	73.28	95% Gamma Adjusted KM-UCL (use when n<50)	75.53

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.377	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.414	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.148	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	18.1	Mean in Log Scale	-0.735
SD in Original Scale	107.1	SD in Log Scale	1.384
95% t UCL (assumes normality of ROS data)	38.99	95% Percentile Bootstrap UCL	43.03
95% BCA Bootstrap UCL	50.41	95% Bootstrap t UCL	4504
95% H-UCL (Log ROS)	1.929		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.885	KM Geo Mean	0.413
KM SD (logged)	1.26	95% Critical H Value (KM-Log)	2.522
KM Standard Error of Mean (logged)	0.153	95% H-UCL (KM -Log)	1.327
KM SD (logged)	1.26	95% Critical H Value (KM-Log)	2.522
KM Standard Error of Mean (logged)	0.153		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	18.63	Mean in Log Scale	-0.393
SD in Original Scale	107	SD in Log Scale	1.454
95% t UCL (Assumes normality)	39.5	95% H-Stat UCL	3.111

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 73.01

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	77	Number of Distinct Observations	70
Number of Detects	76	Number of Non-Detects	1
Number of Distinct Detects	69	Number of Distinct Non-Detects	1

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	2.6	Minimum Non-Detect	2.24
Maximum Detect	326	Maximum Non-Detect	2.24
Variance Detects	2206	Percent Non-Detects	1.299%
Mean Detects	22.69	SD Detects	46.97
Median Detects	9.8	CV Detects	2.07
Skewness Detects	5.072	Kurtosis Detects	28.49
Mean of Logged Detects	2.467	SD of Logged Detects	0.922

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.4	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.347	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.102	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	22.43	KM Standard Error of Mean	5.325
KM SD	46.42	95% KM (BCA) UCL	31.8
95% KM (t) UCL	31.29	95% KM (Percentile Bootstrap) UCL	31.69
95% KM (z) UCL	31.19	95% KM Bootstrap t UCL	44.71
90% KM Chebyshev UCL	38.4	95% KM Chebyshev UCL	45.64
97.5% KM Chebyshev UCL	55.68	99% KM Chebyshev UCL	75.41

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.421	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.786	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.309	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.106	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.894	k star (bias corrected MLE)	0.867
Theta hat (MLE)	25.39	Theta star (bias corrected MLE)	26.16
nu hat (MLE)	135.9	nu star (bias corrected)	131.8
Mean (detects)	22.69		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	22.4
Maximum	326	Median	9.8
SD	46.73	CV	2.086
k hat (MLE)	0.808	k star (bias corrected MLE)	0.785
Theta hat (MLE)	27.72	Theta star (bias corrected MLE)	28.52
nu hat (MLE)	124.5	nu star (bias corrected)	120.9
Adjusted Level of Significance (β)	0.0469		
Approximate Chi Square Value (120.94, α)	96.55	Adjusted Chi Square Value (120.94, β)	96.13
95% Gamma Approximate UCL (use when n>=50)	28.06	95% Gamma Adjusted UCL (use when n<50)	28.18

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	22.43	SD (KM)	46.42
Variance (KM)	2154	SE of Mean (KM)	5.325
k hat (KM)	0.233	k star (KM)	0.233
nu hat (KM)	35.96	nu star (KM)	35.89
theta hat (KM)	96.06	theta star (KM)	96.24
80% gamma percentile (KM)	31.72	90% gamma percentile (KM)	67.6
95% gamma percentile (KM)	110.8	99% gamma percentile (KM)	227

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (35.89, α)	23.18	Adjusted Chi Square Value (35.89, β)	22.98
95% Gamma Approximate KM-UCL (use when n>=50)	34.73	95% Gamma Adjusted KM-UCL (use when n<50)	35.02

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.849	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	1.477E-10	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.102	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	22.41	Mean in Log Scale	2.438
SD in Original Scale	46.73	SD in Log Scale	0.952
95% t UCL (assumes normality of ROS data)	31.28	95% Percentile Bootstrap UCL	31.81
95% BCA Bootstrap UCL	36.41	95% Bootstrap t UCL	43.21
95% H-UCL (Log ROS)	22.94		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.446	KM Geo Mean	11.54
KM SD (logged)	0.929	95% Critical H Value (KM-Log)	2.193
KM Standard Error of Mean (logged)	0.107	95% H-UCL (KM -Log)	22.44
KM SD (logged)	0.929	95% Critical H Value (KM-Log)	2.193
KM Standard Error of Mean (logged)	0.107		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	22.41	Mean in Log Scale	2.437
SD in Original Scale	46.73	SD in Log Scale	0.954
95% t UCL (Assumes normality)	31.28	95% H-Stat UCL	22.98

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 45.64

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Barium (mg/kg)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	74
Number of Detects	81	Number of Non-Detects	1
Number of Distinct Detects	73	Number of Distinct Non-Detects	1
Minimum Detect	7	Minimum Non-Detect	25.7
Maximum Detect	510	Maximum Non-Detect	25.7
Variance Detects	14871	Percent Non-Detects	1.22%
Mean Detects	143.9	SD Detects	121.9
Median Detects	110	CV Detects	0.848
Skewness Detects	1.721	Kurtosis Detects	2.39
Mean of Logged Detects	4.65	SD of Logged Detects	0.841

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.778	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.181	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	142.3	KM Standard Error of Mean	13.48
KM SD	121.3	95% KM (BCA) UCL	165.9
95% KM (t) UCL	164.7	95% KM (Percentile Bootstrap) UCL	165.8
95% KM (z) UCL	164.5	95% KM Bootstrap t UCL	168.5
90% KM Chebyshev UCL	182.7	95% KM Chebyshev UCL	201
97.5% KM Chebyshev UCL	226.5	99% KM Chebyshev UCL	276.4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.097	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.767	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0826	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.101	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.717	k star (bias corrected MLE)	1.662
Theta hat (MLE)	83.78	Theta star (bias corrected MLE)	86.57
nu hat (MLE)	278.2	nu star (bias corrected)	269.2
Mean (detects)	143.9		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	142.1
Maximum	510	Median	106
SD	122.2	CV	0.86
k hat (MLE)	1.335	k star (bias corrected MLE)	1.294
Theta hat (MLE)	106.5	Theta star (bias corrected MLE)	109.8
nu hat (MLE)	218.9	nu star (bias corrected)	212.2
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (212.24, α)	179.5	Adjusted Chi Square Value (212.24, β)	179
95% Gamma Approximate UCL (use when n>=50)	168	95% Gamma Adjusted UCL (use when n<50)	168.5

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	142.3	SD (KM)	121.3
Variance (KM)	14706	SE of Mean (KM)	13.48
k hat (KM)	1.377	k star (KM)	1.335
nu hat (KM)	225.8	nu star (KM)	218.9
theta hat (KM)	103.3	theta star (KM)	106.6
80% gamma percentile (KM)	222.9	90% gamma percentile (KM)	305.1
95% gamma percentile (KM)	385.6	99% gamma percentile (KM)	568.7

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (218.87, α)	185.6	Adjusted Chi Square Value (218.87, β)	185.1
95% Gamma Approximate KM-UCL (use when n>=50)	167.8	95% Gamma Adjusted KM-UCL (use when n<50)	168.3

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.961	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0557	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0691	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	142.3	Mean in Log Scale	4.63
SD in Original Scale	122	SD in Log Scale	0.855
95% t UCL (assumes normality of ROS data)	164.8	95% Percentile Bootstrap UCL	166.6
95% BCA Bootstrap UCL	166.6	95% Bootstrap t UCL	168.5
95% H-UCL (Log ROS)	180.4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.625	KM Geo Mean	102
KM SD (logged)	0.862	95% Critical H Value (KM-Log)	2.106
KM Standard Error of Mean (logged)	0.0961	95% H-UCL (KM -Log)	181
KM SD (logged)	0.862	95% Critical H Value (KM-Log)	2.106
KM Standard Error of Mean (logged)	0.0961		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	142.3	Mean in Log Scale	4.625
SD in Original Scale	122.1	SD in Log Scale	0.867
95% t UCL (Assumes normality)	164.7	95% H-Stat UCL	181.9

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL 167.8 95% GROS Approximate Gamma UCL 168

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	23
Number of Detects	76	Number of Non-Detects	8
Number of Distinct Detects	19	Number of Distinct Non-Detects	5
Minimum Detect	0.3	Minimum Non-Detect	0.446
Maximum Detect	2.19	Maximum Non-Detect	2
Variance Detects	0.203	Percent Non-Detects	9.524%
Mean Detects	1.148	SD Detects	0.451
Median Detects	1	CV Detects	0.393
Skewness Detects	0.631	Kurtosis Detects	-0.159
Mean of Logged Detects	0.0578	SD of Logged Detects	0.418

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.913	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	1.8973E-5	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.168	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.102	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.114	KM Standard Error of Mean	0.0507
KM SD	0.453	95% KM (BCA) UCL	1.213
95% KM (t) UCL	1.199	95% KM (Percentile Bootstrap) UCL	1.198
95% KM (z) UCL	1.198	95% KM Bootstrap t UCL	1.201
90% KM Chebyshev UCL	1.267	95% KM Chebyshev UCL	1.335
97.5% KM Chebyshev UCL	1.431	99% KM Chebyshev UCL	1.619

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.308	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.122	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.103	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	6.4	k star (bias corrected MLE)	6.156
Theta hat (MLE)	0.179	Theta star (bias corrected MLE)	0.186
nu hat (MLE)	972.8	nu star (bias corrected)	935.7
Mean (detects)	1.148		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.3	Mean	1.117
Maximum	2.19	Median	1
SD	0.448	CV	0.401
k hat (MLE)	6.183	k star (bias corrected MLE)	5.97
Theta hat (MLE)	0.181	Theta star (bias corrected MLE)	0.187
nu hat (MLE)	1039	nu star (bias corrected)	1003
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (N/A, α)	930.5	Adjusted Chi Square Value (N/A, β)	929.3
95% Gamma Approximate UCL (use when n>=50)	1.204	95% Gamma Adjusted UCL (use when n<50)	1.206

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.114	SD (KM)	0.453
Variance (KM)	0.206	SE of Mean (KM)	0.0507
k hat (KM)	6.04	k star (KM)	5.832
nu hat (KM)	1015	nu star (KM)	979.8
theta hat (KM)	0.184	theta star (KM)	0.191
80% gamma percentile (KM)	1.473	90% gamma percentile (KM)	1.731
95% gamma percentile (KM)	1.966	99% gamma percentile (KM)	2.457

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (979.84, α)	908.2	Adjusted Chi Square Value (979.84, β)	907
95% Gamma Approximate KM-UCL (use when n>=50)	1.202	95% Gamma Adjusted KM-UCL (use when n<50)	1.204

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.934	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	7.8106E-4	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.138	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.102	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.116	Mean in Log Scale	0.0273
SD in Original Scale	0.447	SD in Log Scale	0.421
95% t UCL (assumes normality of ROS data)	1.197	95% Percentile Bootstrap UCL	1.194
95% BCA Bootstrap UCL	1.198	95% Bootstrap t UCL	1.204
95% H-UCL (Log ROS)	1.22		

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.0182	KM Geo Mean	1.018
KM SD (logged)	0.445	95% Critical H Value (KM-Log)	1.812
KM Standard Error of Mean (logged)	0.0504	95% H-UCL (KM -Log)	1.228
KM SD (logged)	0.445	95% Critical H Value (KM-Log)	1.812
KM Standard Error of Mean (logged)	0.0504		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.106	Mean in Log Scale	0.00665
SD in Original Scale	0.458	SD in Log Scale	0.461
95% t UCL (Assumes normality)	1.189	95% H-Stat UCL	1.227

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.199	KM H-UCL	1.228
95% KM (BCA) UCL	1.213		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	98	Number of Distinct Observations	92
Number of Detects	97	Number of Non-Detects	1
Number of Distinct Detects	91	Number of Distinct Non-Detects	1
Minimum Detect	0.33	Minimum Non-Detect	0.726
Maximum Detect	4170	Maximum Non-Detect	0.726
Variance Detects	228101	Percent Non-Detects	1.02%
Mean Detects	148.8	SD Detects	477.6
Median Detects	53	CV Detects	3.209
Skewness Detects	7.125	Kurtosis Detects	55.95
Mean of Logged Detects	3.258	SD of Logged Detects	2.127

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.306	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.378	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0902	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	147.3	KM Standard Error of Mean	48.02
KM SD	472.9	95% KM (BCA) UCL	239.2
95% KM (t) UCL	227.1	95% KM (Percentile Bootstrap) UCL	236.2
95% KM (z) UCL	226.3	95% KM Bootstrap t UCL	439.3
90% KM Chebyshev UCL	291.4	95% KM Chebyshev UCL	356.6
97.5% KM Chebyshev UCL	447.2	99% KM Chebyshev UCL	625.1

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.431	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.848	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.122	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0976	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.38	k star (bias corrected MLE)	0.375
Theta hat (MLE)	391.5	Theta star (bias corrected MLE)	396.6
nu hat (MLE)	73.75	nu star (bias corrected)	72.8
Mean (detects)	148.8		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	147.3
Maximum	4170	Median	51.1
SD	475.4	CV	3.227
k hat (MLE)	0.368	k star (bias corrected MLE)	0.363
Theta hat (MLE)	400.8	Theta star (bias corrected MLE)	405.7
nu hat (MLE)	72.03	nu star (bias corrected)	71.16
Adjusted Level of Significance (β)	0.0476		
Approximate Chi Square Value (71.16, α)	52.74	Adjusted Chi Square Value (71.16, β)	52.5
95% Gamma Approximate UCL (use when n>=50)	198.8	95% Gamma Adjusted UCL (use when n<50)	199.7

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	147.3	SD (KM)	472.9
Variance (KM)	223668	SE of Mean (KM)	48.02
k hat (KM)	0.097	k star (KM)	0.101
nu hat (KM)	19.02	nu star (KM)	19.77
theta hat (KM)	1518	theta star (KM)	1461
80% gamma percentile (KM)	103.5	90% gamma percentile (KM)	393.4
95% gamma percentile (KM)	854.6	99% gamma percentile (KM)	2330

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (19.77, α)	10.68	Adjusted Chi Square Value (19.77, β)	10.58
95% Gamma Approximate KM-UCL (use when n>=50)	272.7	95% Gamma Adjusted KM-UCL (use when n<50)	275.2

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.935	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.0883E-4	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0902	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	147.3	Mean in Log Scale	3.217
SD in Original Scale	475.4	SD in Log Scale	2.153
95% t UCL (assumes normality of ROS data)	227.1	95% Percentile Bootstrap UCL	233
95% BCA Bootstrap UCL	279.7	95% Bootstrap t UCL	423.2
95% H-UCL (Log ROS)	558		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.217	KM Geo Mean	24.97
KM SD (logged)	2.142	95% Critical H Value (KM-Log)	3.596
KM Standard Error of Mean (logged)	0.218	95% H-UCL (KM -Log)	540.9
KM SD (logged)	2.142	95% Critical H Value (KM-Log)	3.596
KM Standard Error of Mean (logged)	0.218		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	147.3	Mean in Log Scale	3.214
SD in Original Scale	475.4	SD in Log Scale	2.159
95% t UCL (Assumes normality)	227.1	95% H-Stat UCL	566.2

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	356.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	42
Number of Detects	83	Number of Non-Detects	1
Number of Distinct Detects	41	Number of Distinct Non-Detects	1
Minimum Detect	5	Minimum Non-Detect	60
Maximum Detect	111	Maximum Non-Detect	60
Variance Detects	370.8	Percent Non-Detects	1.19%
Mean Detects	24.38	SD Detects	19.26
Median Detects	18	CV Detects	0.79
Skewness Detects	2.633	Kurtosis Detects	8.428
Mean of Logged Detects	2.991	SD of Logged Detects	0.6

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.707	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.256	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0974	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	24.33	KM Standard Error of Mean	2.098
KM SD	19.07	95% KM (BCA) UCL	27.81
95% KM (t) UCL	27.82	95% KM (Percentile Bootstrap) UCL	27.67
95% KM (z) UCL	27.78	95% KM Bootstrap t UCL	28.83
90% KM Chebyshev UCL	30.63	95% KM Chebyshev UCL	33.48
97.5% KM Chebyshev UCL	37.44	99% KM Chebyshev UCL	45.21

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.15	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.761	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.197	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.099	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.622	k star (bias corrected MLE)	2.535
Theta hat (MLE)	9.298	Theta star (bias corrected MLE)	9.616
nu hat (MLE)	435.2	nu star (bias corrected)	420.8
Mean (detects)	24.38		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5	Mean	24.32
Maximum	111	Median	18
SD	19.15	CV	0.787
k hat (MLE)	2.648	k star (bias corrected MLE)	2.561
Theta hat (MLE)	9.183	Theta star (bias corrected MLE)	9.494
nu hat (MLE)	444.9	nu star (bias corrected)	430.3
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (430.33, α)	383.2	Adjusted Chi Square Value (430.33, β)	382.5
95% Gamma Approximate UCL (use when n>=50)	27.31	95% Gamma Adjusted UCL (use when n<50)	27.36

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	24.33	SD (KM)	19.07
Variance (KM)	363.7	SE of Mean (KM)	2.098
k hat (KM)	1.628	k star (KM)	1.578
nu hat (KM)	273.5	nu star (KM)	265
theta hat (KM)	14.95	theta star (KM)	15.42
80% gamma percentile (KM)	37.44	90% gamma percentile (KM)	50.09
95% gamma percentile (KM)	62.33	99% gamma percentile (KM)	89.88

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (265.03, α)	228.3	Adjusted Chi Square Value (265.03, β)	227.7
95% Gamma Approximate KM-UCL (use when n>=50)	28.24	95% Gamma Adjusted KM-UCL (use when n<50)	28.32

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.949	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.00623	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0974	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	24.31	Mean in Log Scale	2.99
SD in Original Scale	19.15	SD in Log Scale	0.596
95% t UCL (assumes normality of ROS data)	27.79	95% Percentile Bootstrap UCL	28.01
95% BCA Bootstrap UCL	28.45	95% Bootstrap t UCL	28.67
95% H-UCL (Log ROS)	26.91		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.99	KM Geo Mean	19.88
KM SD (logged)	0.595	95% Critical H Value (KM-Log)	1.905
KM Standard Error of Mean (logged)	0.0656	95% H-UCL (KM -Log)	26.88
KM SD (logged)	0.595	95% Critical H Value (KM-Log)	1.905
KM Standard Error of Mean (logged)	0.0656		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	24.44	Mean in Log Scale	2.996
SD in Original Scale	19.15	SD in Log Scale	0.598
95% t UCL (Assumes normality)	27.92	95% H-Stat UCL	27.1

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	33.48

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	36
Number of Detects	80	Number of Non-Detects	4
Number of Distinct Detects	33	Number of Distinct Non-Detects	4

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	1	Minimum Non-Detect	5
Maximum Detect	390	Maximum Non-Detect	60
Variance Detects	1832	Percent Non-Detects	4.762%
Mean Detects	18.56	SD Detects	42.8
Median Detects	13.5	CV Detects	2.307
Skewness Detects	8.479	Kurtosis Detects	74.33
Mean of Logged Detects	2.496	SD of Logged Detects	0.752

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.244	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.381	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	18	KM Standard Error of Mean	4.569
KM SD	41.61	95% KM (BCA) UCL	27.48
95% KM (t) UCL	25.6	95% KM (Percentile Bootstrap) UCL	26.96
95% KM (z) UCL	25.51	95% KM Bootstrap t UCL	48.97
90% KM Chebyshev UCL	31.7	95% KM Chebyshev UCL	37.91
97.5% KM Chebyshev UCL	46.53	99% KM Chebyshev UCL	63.46

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.824	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.775	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.215	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.102	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.318	k star (bias corrected MLE)	1.277
Theta hat (MLE)	14.08	Theta star (bias corrected MLE)	14.54
nu hat (MLE)	210.8	nu star (bias corrected)	204.2
Mean (detects)	18.56		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	17.79
Maximum	390	Median	12
SD	41.91	CV	2.356
k hat (MLE)	0.913	k star (bias corrected MLE)	0.889
Theta hat (MLE)	19.48	Theta star (bias corrected MLE)	20.02
nu hat (MLE)	153.4	nu star (bias corrected)	149.3
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (149.27, α)	122	Adjusted Chi Square Value (149.27, β)	121.6
95% Gamma Approximate UCL (use when n>=50)	21.76	95% Gamma Adjusted UCL (use when n<50)	21.84

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	18	SD (KM)	41.61
Variance (KM)	1731	SE of Mean (KM)	4.569
k hat (KM)	0.187	k star (KM)	0.188
nu hat (KM)	31.43	nu star (KM)	31.64
theta hat (KM)	96.19	theta star (KM)	95.55
80% gamma percentile (KM)	22.94	90% gamma percentile (KM)	54.37
95% gamma percentile (KM)	94.16	99% gamma percentile (KM)	204.8

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (31.64, α)	19.79	Adjusted Chi Square Value (31.64, β)	19.63
95% Gamma Approximate KM-UCL (use when n>=50)	28.78	95% Gamma Adjusted KM-UCL (use when n<50)	29.02

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.935	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	6.6309E-4	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.116	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0991	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	17.97	Mean in Log Scale	2.459
SD in Original Scale	41.85	SD in Log Scale	0.759
95% t UCL (assumes normality of ROS data)	25.57	95% Percentile Bootstrap UCL	27.14
95% BCA Bootstrap UCL	32.48	95% Bootstrap t UCL	48.85
95% H-UCL (Log ROS)	18.49		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.455	KM Geo Mean	11.64
KM SD (logged)	0.77	95% Critical H Value (KM-Log)	2.046
KM Standard Error of Mean (logged)	0.0857	95% H-UCL (KM -Log)	18.62
KM SD (logged)	0.77	95% Critical H Value (KM-Log)	2.046
KM Standard Error of Mean (logged)	0.0857		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	18.16	Mean in Log Scale	2.461
SD in Original Scale	41.87	SD in Log Scale	0.78
95% t UCL (Assumes normality)	25.76	95% H-Stat UCL	18.93

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	37.91

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Copper (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	58
Number of Detects	83	Number of Non-Detects	1
Number of Distinct Detects	58	Number of Distinct Non-Detects	1
Minimum Detect	7.15	Minimum Non-Detect	60
Maximum Detect	319	Maximum Non-Detect	60
Variance Detects	3683	Percent Non-Detects	1.19%
Mean Detects	57.91	SD Detects	60.69
Median Detects	39	CV Detects	1.048
Skewness Detects	2	Kurtosis Detects	4.703
Mean of Logged Detects	3.56	SD of Logged Detects	1.032

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.776	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.201	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0974	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	57.48	KM Standard Error of Mean	6.6
KM SD	60.11	95% KM (BCA) UCL	67.23
95% KM (t) UCL	68.46	95% KM (Percentile Bootstrap) UCL	68.38
95% KM (z) UCL	68.34	95% KM Bootstrap t UCL	70.2
90% KM Chebyshev UCL	77.28	95% KM Chebyshev UCL	86.25
97.5% KM Chebyshev UCL	98.7	99% KM Chebyshev UCL	123.2

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.721	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.779	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.123	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.101	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.14	k star (bias corrected MLE)	1.107
Theta hat (MLE)	50.79	Theta star (bias corrected MLE)	52.31
nu hat (MLE)	189.3	nu star (bias corrected)	183.8
Mean (detects)	57.91		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum	7.15	Mean	57.44
Maximum	319	Median	38
SD	60.47	CV	1.053
k hat (MLE)	1.141	k star (bias corrected MLE)	1.108
Theta hat (MLE)	50.33	Theta star (bias corrected MLE)	51.82
nu hat (MLE)	191.7	nu star (bias corrected)	186.2
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (186.20, α)	155.6	Adjusted Chi Square Value (186.20, β)	155.2
95% Gamma Approximate UCL (use when n>=50)	68.72	95% Gamma Adjusted UCL (use when n<50)	68.93

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	57.48	SD (KM)	60.11
Variance (KM)	3613	SE of Mean (KM)	6.6
k hat (KM)	0.915	k star (KM)	0.89
nu hat (KM)	153.6	nu star (KM)	149.5
theta hat (KM)	62.85	theta star (KM)	64.6
80% gamma percentile (KM)	93.32	90% gamma percentile (KM)	136.2
95% gamma percentile (KM)	179.5	99% gamma percentile (KM)	280.9

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (149.48, α)	122.2	Adjusted Chi Square Value (149.48, β)	121.8
95% Gamma Approximate KM-UCL (use when n>=50)	70.3	95% Gamma Adjusted KM-UCL (use when n<50)	70.55

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.922	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	3.3025E-5	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.123	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0974	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	57.47	Mean in Log Scale	3.554
SD in Original Scale	60.46	SD in Log Scale	1.027
95% t UCL (assumes normality of ROS data)	68.44	95% Percentile Bootstrap UCL	68.19
95% BCA Bootstrap UCL	70.78	95% Bootstrap t UCL	70.67
95% H-UCL (Log ROS)	76.43		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.552	KM Geo Mean	34.88
KM SD (logged)	1.024	95% Critical H Value (KM-Log)	2.259
KM Standard Error of Mean (logged)	0.113	95% H-UCL (KM -Log)	76
KM SD (logged)	1.024	95% Critical H Value (KM-Log)	2.259
KM Standard Error of Mean (logged)	0.113		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	57.58	Mean in Log Scale	3.558
SD in Original Scale	60.4	SD in Log Scale	1.026
95% t UCL (Assumes normality)	68.54	95% H-Stat UCL	76.61

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use
95% KM (Chebyshev) UCL 86.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	79
		Number of Missing Observations	0
Minimum	1.9	Mean	44791
Maximum	497000	Median	21350
SD	71343	Std. Error of Mean	7784
Coefficient of Variation	1.593	Skewness	3.876

Normal GOF Test

Shapiro Wilk Test Statistic	0.577	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.33	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0968	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	57739	95% Adjusted-CLT UCL (Chen-1995)	61112
		95% Modified-t UCL (Johnson-1978)	58288

Gamma GOF Test

A-D Test Statistic	6.433	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.84	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.274	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.104	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.409	k star (bias corrected MLE)	0.403
Theta hat (MLE)	109399	Theta star (bias corrected MLE)	111215
nu hat (MLE)	68.78	nu star (bias corrected)	67.66
MLE Mean (bias corrected)	44791	MLE Sd (bias corrected)	70579
		Approximate Chi Square Value (0.05)	49.73
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	49.46

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	60942	95% Adjusted Gamma UCL (use when n<50)	61272

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.636	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.36	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.642	Mean of logged Data	9.109
Maximum of Logged Data	13.12	SD of logged Data	3.286

Assuming Lognormal Distribution

95% H-UCL	12478339	90% Chebyshev (MVUE) UCL	4156342
95% Chebyshev (MVUE) UCL	5403630	97.5% Chebyshev (MVUE) UCL	7134817
99% Chebyshev (MVUE) UCL	10535399		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	57595	95% Jackknife UCL	57739
95% Standard Bootstrap UCL	57672	95% Bootstrap-t UCL	63944
95% Hall's Bootstrap UCL	69983	95% Percentile Bootstrap UCL	58023
95% BCA Bootstrap UCL	61504		
90% Chebyshev(Mean, Sd) UCL	68144	95% Chebyshev(Mean, Sd) UCL	78721
97.5% Chebyshev(Mean, Sd) UCL	93403	99% Chebyshev(Mean, Sd) UCL	122243

Suggested UCL to Use

97.5% Chebyshev (Mean, Sd) UCL 93403

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	98	Number of Distinct Observations	96
		Number of Missing Observations	0
Minimum	18.1	Mean	1095
Maximum	7280	Median	508
SD	1378	Std. Error of Mean	139.2
Coefficient of Variation	1.259	Skewness	2.018

Normal GOF Test

Shapiro Wilk Test Statistic	0.765	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.217	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0897	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1326	95% Adjusted-CLT UCL (Chen-1995)	1354
		95% Modified-t UCL (Johnson-1978)	1331

Gamma GOF Test

A-D Test Statistic	1.525	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.808	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.119	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0949	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.61	k star (bias corrected MLE)	0.598
Theta hat (MLE)	1794	Theta star (bias corrected MLE)	1829
nu hat (MLE)	119.6	nu star (bias corrected)	117.3
MLE Mean (bias corrected)	1095	MLE Sd (bias corrected)	1415
		Approximate Chi Square Value (0.05)	93.3
Adjusted Level of Significance	0.0476	Adjusted Chi Square Value	92.98

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1377	95% Adjusted Gamma UCL (use when n<50)	1381

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.912	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	3.0544E-7	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.121	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0897	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.896	Mean of logged Data	5.989
Maximum of Logged Data	8.893	SD of logged Data	1.66

Assuming Lognormal Distribution

95% H-UCL	2618	90% Chebyshev (MVUE) UCL	2647
95% Chebyshev (MVUE) UCL	3152	97.5% Chebyshev (MVUE) UCL	3853
99% Chebyshev (MVUE) UCL	5231		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	1324	95% Jackknife UCL	1326
95% Standard Bootstrap UCL	1322	95% Bootstrap-t UCL	1355
95% Hall's Bootstrap UCL	1350	95% Percentile Bootstrap UCL	1330
95% BCA Bootstrap UCL	1376		
90% Chebyshev(Mean, Sd) UCL	1513	95% Chebyshev(Mean, Sd) UCL	1702
97.5% Chebyshev(Mean, Sd) UCL	1964	99% Chebyshev(Mean, Sd) UCL	2480

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 1702

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lithium (mg/kg)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	21	Mean	36.18
Maximum	48	Median	36
SD	8.316	Std. Error of Mean	2.508
Coefficient of Variation	0.23	Skewness	-0.228

Normal GOF Test

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.135	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	40.73	95% Adjusted-CLT UCL (Chen-1995)	40.12
		95% Modified-t UCL (Johnson-1978)	40.7

Gamma GOF Test

A-D Test Statistic	0.269	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	19.23	k star (bias corrected MLE)	14.04
Theta hat (MLE)	1.882	Theta star (bias corrected MLE)	2.577
nu hat (MLE)	423	nu star (bias corrected)	308.9
MLE Mean (bias corrected)	36.18	MLE Sd (bias corrected)	9.655
		Approximate Chi Square Value (0.05)	269.2
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	263.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	41.52	95% Adjusted Gamma UCL (use when n<50)	42.47

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.045	Mean of logged Data	3.562
Maximum of Logged Data	3.871	SD of logged Data	0.247

Assuming Lognormal Distribution

95% H-UCL	42.13	90% Chebyshev (MVUE) UCL	44.35
95% Chebyshev (MVUE) UCL	48.03	97.5% Chebyshev (MVUE) UCL	53.14
99% Chebyshev (MVUE) UCL	63.17		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	40.31	95% Jackknife UCL	40.73
95% Standard Bootstrap UCL	40.15	95% Bootstrap-t UCL	40.49
95% Hall's Bootstrap UCL	40.21	95% Percentile Bootstrap UCL	40.18
95% BCA Bootstrap UCL	39.82		
90% Chebyshev(Mean, Sd) UCL	43.7	95% Chebyshev(Mean, Sd) UCL	47.11
97.5% Chebyshev(Mean, Sd) UCL	51.84	99% Chebyshev(Mean, Sd) UCL	61.13

Suggested UCL to Use

95% Student's-t UCL 40.73

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Manganese (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	80
		Number of Missing Observations	0
Minimum	38	Mean	806.4
Maximum	11300	Median	550
SD	1268	Std. Error of Mean	138.4
Coefficient of Variation	1.573	Skewness	7.104

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.396	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.316	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1037	95% Adjusted-CLT UCL (Chen-1995)	1149
		95% Modified-t UCL (Johnson-1978)	1054

Gamma GOF Test

A-D Test Statistic	2.741	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.771	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.155	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0993	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.492	k star (bias corrected MLE)	1.447
Theta hat (MLE)	540.4	Theta star (bias corrected MLE)	557.4
nu hat (MLE)	250.7	nu star (bias corrected)	243.1
MLE Mean (bias corrected)	806.4	MLE Sd (bias corrected)	670.4
		Approximate Chi Square Value (0.05)	208
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	207.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	942.5	95% Adjusted Gamma UCL (use when n<50)	945

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.231	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.101	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.638	Mean of logged Data	6.321
Maximum of Logged Data	9.333	SD of logged Data	0.785

Assuming Lognormal Distribution

95% H-UCL	904.1	90% Chebyshev (MVUE) UCL	972.2
95% Chebyshev (MVUE) UCL	1071	97.5% Chebyshev (MVUE) UCL	1208
99% Chebyshev (MVUE) UCL	1478		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	1034	95% Jackknife UCL	1037
95% Standard Bootstrap UCL	1033	95% Bootstrap-t UCL	1372
95% Hall's Bootstrap UCL	1933	95% Percentile Bootstrap UCL	1071
95% BCA Bootstrap UCL	1214		
90% Chebyshev(Mean, Sd) UCL	1222	95% Chebyshev(Mean, Sd) UCL	1410
97.5% Chebyshev(Mean, Sd) UCL	1671	99% Chebyshev(Mean, Sd) UCL	2183

Suggested UCL to Use

95% H-UCL 904.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Mercury (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	32
Number of Detects	43	Number of Non-Detects	31
Number of Distinct Detects	31	Number of Distinct Non-Detects	4
Minimum Detect	0.02	Minimum Non-Detect	0.2
Maximum Detect	1.06	Maximum Non-Detect	0.9
Variance Detects	0.0478	Percent Non-Detects	41.89%
Mean Detects	0.237	SD Detects	0.219
Median Detects	0.18	CV Detects	0.921
Skewness Detects	2.02	Kurtosis Detects	4.427
Mean of Logged Detects	-1.785	SD of Logged Detects	0.857

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.783	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.943	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.134	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.195	KM Standard Error of Mean	0.0223
KM SD	0.179	95% KM (BCA) UCL	0.234
95% KM (t) UCL	0.232	95% KM (Percentile Bootstrap) UCL	0.233
95% KM (z) UCL	0.232	95% KM Bootstrap t UCL	0.239
90% KM Chebyshev UCL	0.262	95% KM Chebyshev UCL	0.292
97.5% KM Chebyshev UCL	0.334	99% KM Chebyshev UCL	0.417

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.524	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.766	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.104	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.137	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.588	k star (bias corrected MLE)	1.493
Theta hat (MLE)	0.15	Theta star (bias corrected MLE)	0.159
nu hat (MLE)	136.6	nu star (bias corrected)	128.4
Mean (detects)	0.237		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.192
Maximum	1.06	Median	0.148
SD	0.184	CV	0.957
k hat (MLE)	1.391	k star (bias corrected MLE)	1.343
Theta hat (MLE)	0.138	Theta star (bias corrected MLE)	0.143
nu hat (MLE)	205.8	nu star (bias corrected)	198.8
Adjusted Level of Significance (β)	0.0468		
Approximate Chi Square Value (198.80, α)	167.2	Adjusted Chi Square Value (198.80, β)	166.6
95% Gamma Approximate UCL (use when n>=50)	0.229	95% Gamma Adjusted UCL (use when n<50)	0.23

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.195	SD (KM)	0.179
Variance (KM)	0.032	SE of Mean (KM)	0.0223
k hat (KM)	1.188	k star (KM)	1.149
nu hat (KM)	175.8	nu star (KM)	170
theta hat (KM)	0.164	theta star (KM)	0.17
80% gamma percentile (KM)	0.31	90% gamma percentile (KM)	0.434
95% gamma percentile (KM)	0.556	99% gamma percentile (KM)	0.838

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (169.99, α)	140.8	Adjusted Chi Square Value (169.99, β)	140.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.235	95% Gamma Adjusted KM-UCL (use when n<50)	0.236

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.99	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.943	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0631	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.134	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.193	Mean in Log Scale	-1.945
SD in Original Scale	0.179	SD in Log Scale	0.765
95% t UCL (assumes normality of ROS data)	0.228	95% Percentile Bootstrap UCL	0.23
95% BCA Bootstrap UCL	0.235	95% Bootstrap t UCL	0.238
95% H-UCL (Log ROS)	0.23		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.945	KM Geo Mean	0.143
KM SD (logged)	0.788	95% Critical H Value (KM-Log)	2.063
KM Standard Error of Mean (logged)	0.113	95% H-UCL (KM -Log)	0.236
KM SD (logged)	0.788	95% Critical H Value (KM-Log)	2.063
KM Standard Error of Mean (logged)	0.113		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.204	Mean in Log Scale	-1.829
SD in Original Scale	0.175	SD in Log Scale	0.677
95% t UCL (Assumes normality)	0.238	95% H-Stat UCL	0.236

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.235	95% GROS Approximate Gamma UCL	0.229

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/kg)

General Statistics

Total Number of Observations	72	Number of Distinct Observations	15
Number of Detects	35	Number of Non-Detects	37
Number of Distinct Detects	14	Number of Distinct Non-Detects	3
Minimum Detect	1	Minimum Non-Detect	1
Maximum Detect	110	Maximum Non-Detect	50
Variance Detects	478.4	Percent Non-Detects	51.39%
Mean Detects	11.66	SD Detects	21.87
Median Detects	5	CV Detects	1.876
Skewness Detects	3.505	Kurtosis Detects	13.1
Mean of Logged Detects	1.515	SD of Logged Detects	1.318

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.51	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.33	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.148	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	6.45	KM Standard Error of Mean	1.909
KM SD	15.91	95% KM (BCA) UCL	10.45
95% KM (t) UCL	9.631	95% KM (Percentile Bootstrap) UCL	9.652
95% KM (z) UCL	9.589	95% KM Bootstrap t UCL	13.79
90% KM Chebyshev UCL	12.18	95% KM Chebyshev UCL	14.77
97.5% KM Chebyshev UCL	18.37	99% KM Chebyshev UCL	25.44

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.036	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.798	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.156	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.649	k star (bias corrected MLE)	0.612
Theta hat (MLE)	17.96	Theta star (bias corrected MLE)	19.04
nu hat (MLE)	45.42	nu star (bias corrected)	42.86
Mean (detects)	11.66		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	6.028
Maximum	110	Median	1
SD	16.15	CV	2.68
k hat (MLE)	0.251	k star (bias corrected MLE)	0.25
Theta hat (MLE)	24	Theta star (bias corrected MLE)	24.12
nu hat (MLE)	36.17	nu star (bias corrected)	35.99
Adjusted Level of Significance (β)	0.0467		
Approximate Chi Square Value (35.99, α)	23.26	Adjusted Chi Square Value (35.99, β)	23.05
95% Gamma Approximate UCL (use when n>=50)	9.326	95% Gamma Adjusted UCL (use when n<50)	9.411

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	6.45	SD (KM)	15.91
Variance (KM)	253.1	SE of Mean (KM)	1.909
k hat (KM)	0.164	k star (KM)	0.167
nu hat (KM)	23.67	nu star (KM)	24.02
theta hat (KM)	39.24	theta star (KM)	38.68
80% gamma percentile (KM)	7.61	90% gamma percentile (KM)	19.35
95% gamma percentile (KM)	34.73	99% gamma percentile (KM)	78.42

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (24.02, α)	13.86	Adjusted Chi Square Value (24.02, β)	13.7
95% Gamma Approximate KM-UCL (use when n>=50)	11.18	95% Gamma Adjusted KM-UCL (use when n<50)	11.3

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.893	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.148	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	6.417	Mean in Log Scale	0.678
SD in Original Scale	16.01	SD in Log Scale	1.457
95% t UCL (assumes normality of ROS data)	9.561	95% Percentile Bootstrap UCL	9.835
95% BCA Bootstrap UCL	10.96	95% Bootstrap t UCL	13.6
95% H-UCL (Log ROS)	9.151		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.88	KM Geo Mean	2.41
KM SD (logged)	1.139	95% Critical H Value (KM-Log)	2.392
KM Standard Error of Mean (logged)	0.145	95% H-UCL (KM -Log)	6.375
KM SD (logged)	1.139	95% Critical H Value (KM-Log)	2.392
KM Standard Error of Mean (logged)	0.145		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	7.465	Mean in Log Scale	1.182
SD in Original Scale	16.12	SD in Log Scale	1.11
95% t UCL (Assumes normality)	10.63	95% H-Stat UCL	8.239

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	14.77

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	54
		Number of Missing Observations	0
Minimum	8	Mean	47.3
Maximum	1050	Median	26
SD	114	Std. Error of Mean	12.43
Coefficient of Variation	2.409	Skewness	8.411

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.27	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.365	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	67.98	95% Adjusted-CLT UCL (Chen-1995)	79.94
		95% Modified-t UCL (Johnson-1978)	69.88

Gamma GOF Test

A-D Test Statistic	4.192	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.779	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.181	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.1	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.125	k star (bias corrected MLE)	1.093
Theta hat (MLE)	42.03	Theta star (bias corrected MLE)	43.27
nu hat (MLE)	189	nu star (bias corrected)	183.6
MLE Mean (bias corrected)	47.3	MLE Sd (bias corrected)	45.24
		Approximate Chi Square Value (0.05)	153.3
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	152.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	56.66	95% Adjusted Gamma UCL (use when n<50)	56.84

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	3.8277E-4	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0732	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0968	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.079	Mean of logged Data	3.35
Maximum of Logged Data	6.957	SD of logged Data	0.814

Assuming Lognormal Distribution

95% H-UCL	47.77	90% Chebyshev (MVUE) UCL	51.45
95% Chebyshev (MVUE) UCL	56.86	97.5% Chebyshev (MVUE) UCL	64.37
99% Chebyshev (MVUE) UCL	79.12		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	67.75	95% Jackknife UCL	67.98
95% Standard Bootstrap UCL	67.76	95% Bootstrap-t UCL	118.8
95% Hall's Bootstrap UCL	146	95% Percentile Bootstrap UCL	71.03
95% BCA Bootstrap UCL	90.36		
90% Chebyshev(Mean, Sd) UCL	84.6	95% Chebyshev(Mean, Sd) UCL	101.5
97.5% Chebyshev(Mean, Sd) UCL	124.9	99% Chebyshev(Mean, Sd) UCL	171

Suggested UCL to Use

95% H-UCL 47.77

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Phosphorus (mg/kg)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	400	Mean	885.5
Maximum	1500	Median	880
SD	367.1	Std. Error of Mean	110.7
Coefficient of Variation	0.415	Skewness	0.34

Normal GOF Test

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.179	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1086	95% Adjusted-CLT UCL (Chen-1995)	1080
		95% Modified-t UCL (Johnson-1978)	1088

Gamma GOF Test

A-D Test Statistic	0.339	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	6.044	k star (bias corrected MLE)	4.456
Theta hat (MLE)	146.5	Theta star (bias corrected MLE)	198.7
nu hat (MLE)	133	nu star (bias corrected)	98.03
MLE Mean (bias corrected)	885.5	MLE Sd (bias corrected)	419.5
		Approximate Chi Square Value (0.05)	76.19
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	73.06

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1139	95% Adjusted Gamma UCL (use when n<50)	1188

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.176	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.991	Mean of logged Data	6.701
Maximum of Logged Data	7.313	SD of logged Data	0.445

Assuming Lognormal Distribution

95% H-UCL	1207	90% Chebyshev (MVUE) UCL	1253
95% Chebyshev (MVUE) UCL	1418	97.5% Chebyshev (MVUE) UCL	1646
99% Chebyshev (MVUE) UCL	2095		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1068	95% Jackknife UCL	1086
95% Standard Bootstrap UCL	1064	95% Bootstrap-t UCL	1124
95% Hall's Bootstrap UCL	1087	95% Percentile Bootstrap UCL	1064
95% BCA Bootstrap UCL	1069		
90% Chebyshev(Mean, Sd) UCL	1218	95% Chebyshev(Mean, Sd) UCL	1368
97.5% Chebyshev(Mean, Sd) UCL	1577	99% Chebyshev(Mean, Sd) UCL	1987

Suggested UCL to Use

95% Student's-t UCL 1086

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Selenium (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	36
Number of Detects	56	Number of Non-Detects	28
Number of Distinct Detects	23	Number of Distinct Non-Detects	14
Minimum Detect	0.5	Minimum Non-Detect	3
Maximum Detect	50	Maximum Non-Detect	50
Variance Detects	49.06	Percent Non-Detects	33.33%
Mean Detects	2.85	SD Detects	7.004
Median Detects	1.1	CV Detects	2.458
Skewness Detects	5.899	Kurtosis Detects	38.73
Mean of Logged Detects	0.331	SD of Logged Detects	0.896

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.334	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.413	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.118	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.357	KM Standard Error of Mean	0.644
KM SD	5.777	95% KM (BCA) UCL	3.585
95% KM (t) UCL	3.428	95% KM (Percentile Bootstrap) UCL	3.495
95% KM (z) UCL	3.416	95% KM Bootstrap t UCL	5.074
90% KM Chebyshev UCL	4.289	95% KM Chebyshev UCL	5.165
97.5% KM Chebyshev UCL	6.38	99% KM Chebyshev UCL	8.767

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.291	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.789	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.314	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.123	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.825	k star (bias corrected MLE)	0.793
Theta hat (MLE)	3.455	Theta star (bias corrected MLE)	3.596
nu hat (MLE)	92.38	nu star (bias corrected)	88.77
Mean (detects)	2.85		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum	0.01	Mean	2.32
Maximum	50	Median	0.95
SD	5.855	CV	2.524
k hat (MLE)	0.606	k star (bias corrected MLE)	0.592
Theta hat (MLE)	3.827	Theta star (bias corrected MLE)	3.915
nu hat (MLE)	101.8	nu star (bias corrected)	99.54
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (99.54, α)	77.52	Adjusted Chi Square Value (99.54, β)	77.18
95% Gamma Approximate UCL (use when n>=50)	2.978	95% Gamma Adjusted UCL (use when n<50)	2.991

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.357	SD (KM)	5.777
Variance (KM)	33.37	SE of Mean (KM)	0.644
k hat (KM)	0.166	k star (KM)	0.168
nu hat (KM)	27.96	nu star (KM)	28.29
theta hat (KM)	14.16	theta star (KM)	13.99
80% gamma percentile (KM)	2.799	90% gamma percentile (KM)	7.077
95% gamma percentile (KM)	12.66	99% gamma percentile (KM)	28.5

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (28.29, α)	17.15	Adjusted Chi Square Value (28.29, β)	17
95% Gamma Approximate KM-UCL (use when n>=50)	3.886	95% Gamma Adjusted KM-UCL (use when n<50)	3.921

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.769	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.449E-11	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.118	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.351	Mean in Log Scale	0.293
SD in Original Scale	5.756	SD in Log Scale	0.77
95% t UCL (assumes normality of ROS data)	3.396	95% Percentile Bootstrap UCL	3.617
95% BCA Bootstrap UCL	4.155	95% Bootstrap t UCL	5.284
95% H-UCL (Log ROS)	2.143		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.259	KM Geo Mean	1.295
KM SD (logged)	0.792	95% Critical H Value (KM-Log)	2.056
KM Standard Error of Mean (logged)	0.0953	95% H-UCL (KM -Log)	2.119
KM SD (logged)	0.792	95% Critical H Value (KM-Log)	2.056
KM Standard Error of Mean (logged)	0.0953		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	5.058	Mean in Log Scale	0.766
SD in Original Scale	8.765	SD in Log Scale	1.148
95% t UCL (Assumes normality)	6.649	95% H-Stat UCL	5.615

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use
95% KM (Chebyshev) UCL 5.165

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silica (as SIO2) (mg/kg)

General Statistics

Total Number of Observations	63	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	2420	Mean	4432
Maximum	7820	Median	4290
SD	1269	Std. Error of Mean	159.9
Coefficient of Variation	0.286	Skewness	0.801

Normal GOF Test

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.0039	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.104	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.111	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4699	95% Adjusted-CLT UCL (Chen-1995)	4712
		95% Modified-t UCL (Johnson-1978)	4702

Gamma GOF Test

A-D Test Statistic	0.406	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0668	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.112	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.11	k star (bias corrected MLE)	12.49
Theta hat (MLE)	338.2	Theta star (bias corrected MLE)	354.8
nu hat (MLE)	1651	nu star (bias corrected)	1574
MLE Mean (bias corrected)	4432	MLE Sd (bias corrected)	1254
		Approximate Chi Square Value (0.05)	1483
Adjusted Level of Significance	0.0462	Adjusted Chi Square Value	1481

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4704	95% Adjusted Gamma UCL (use when n<50)	4711

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.341	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0701	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.111	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.792	Mean of logged Data	8.358
Maximum of Logged Data	8.964	SD of logged Data	0.279

Assuming Lognormal Distribution

95% H-UCL	4716	90% Chebyshev (MVUE) UCL	4906
95% Chebyshev (MVUE) UCL	5121	97.5% Chebyshev (MVUE) UCL	5420
99% Chebyshev (MVUE) UCL	6007		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4695	95% Jackknife UCL	4699
95% Standard Bootstrap UCL	4695	95% Bootstrap-t UCL	4707
95% Hall's Bootstrap UCL	4723	95% Percentile Bootstrap UCL	4689
95% BCA Bootstrap UCL	4717		
90% Chebyshev(Mean, Sd) UCL	4911	95% Chebyshev(Mean, Sd) UCL	5129
97.5% Chebyshev(Mean, Sd) UCL	5430	99% Chebyshev(Mean, Sd) UCL	6022

Suggested UCL to Use

95% Student's-t UCL 4699

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	35
Number of Detects	63	Number of Non-Detects	21
Number of Distinct Detects	26	Number of Distinct Non-Detects	11
Minimum Detect	0.06	Minimum Non-Detect	0.1
Maximum Detect	9.77	Maximum Non-Detect	2.51
Variance Detects	1.519	Percent Non-Detects	25%
Mean Detects	0.348	SD Detects	1.232
Median Detects	0.15	CV Detects	3.539
Skewness Detects	7.464	Kurtosis Detects	57.57
Mean of Logged Detects	-1.883	SD of Logged Detects	0.867

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.22	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.433	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.3	KM Standard Error of Mean	0.117
KM SD	1.065	95% KM (BCA) UCL	0.545
95% KM (t) UCL	0.495	95% KM (Percentile Bootstrap) UCL	0.524
95% KM (z) UCL	0.493	95% KM Bootstrap t UCL	1.285
90% KM Chebyshev UCL	0.652	95% KM Chebyshev UCL	0.812
97.5% KM Chebyshev UCL	1.033	99% KM Chebyshev UCL	1.468

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	9.222	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.795	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.323	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.117	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.726	k star (bias corrected MLE)	0.702
Theta hat (MLE)	0.48	Theta star (bias corrected MLE)	0.496
nu hat (MLE)	91.48	nu star (bias corrected)	88.45
Mean (detects)	0.348		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.297
Maximum	9.77	Median	0.12
SD	1.078	CV	3.63
k hat (MLE)	0.603	k star (bias corrected MLE)	0.59
Theta hat (MLE)	0.492	Theta star (bias corrected MLE)	0.504
nu hat (MLE)	101.3	nu star (bias corrected)	99.05
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (99.05, α)	77.09	Adjusted Chi Square Value (99.05, β)	76.75
95% Gamma Approximate UCL (use when n>=50)	0.382	95% Gamma Adjusted UCL (use when n<50)	0.383

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.3	SD (KM)	1.065
Variance (KM)	1.133	SE of Mean (KM)	0.117
k hat (KM)	0.0794	k star (KM)	0.0845
nu hat (KM)	13.33	nu star (KM)	14.19
theta hat (KM)	3.779	theta star (KM)	3.551
80% gamma percentile (KM)	0.158	90% gamma percentile (KM)	0.735
95% gamma percentile (KM)	1.747	99% gamma percentile (KM)	5.176

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (14.19, α)	6.702	Adjusted Chi Square Value (14.19, β)	6.612
95% Gamma Approximate KM-UCL (use when n>=50)	0.635	95% Gamma Adjusted KM-UCL (use when n<50)	0.644

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.799	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.984E-11	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.299	Mean in Log Scale	-1.911
SD in Original Scale	1.069	SD in Log Scale	0.784
95% t UCL (assumes normality of ROS data)	0.493	95% Percentile Bootstrap UCL	0.52
95% BCA Bootstrap UCL	0.728	95% Bootstrap t UCL	1.55
95% H-UCL (Log ROS)	0.24		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.927	KM Geo Mean	0.146
KM SD (logged)	0.801	95% Critical H Value (KM-Log)	2.06
KM Standard Error of Mean (logged)	0.0946	95% H-UCL (KM -Log)	0.24
KM SD (logged)	0.801	95% Critical H Value (KM-Log)	2.06
KM Standard Error of Mean (logged)	0.0946		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.392	Mean in Log Scale	-1.645
SD in Original Scale	1.084	SD in Log Scale	0.944
95% t UCL (Assumes normality)	0.588	95% H-Stat UCL	0.378

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.812

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Strontium (mg/kg)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	45	Mean	78.73
Maximum	110	Median	83
SD	17.99	Std. Error of Mean	5.424
Coefficient of Variation	0.229	Skewness	-0.143

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	88.56	95% Adjusted-CLT UCL (Chen-1995)	87.4
		95% Modified-t UCL (Johnson-1978)	88.52

Gamma GOF Test

A-D Test Statistic	0.245	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.167	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	19.47	k star (bias corrected MLE)	14.22
Theta hat (MLE)	4.044	Theta star (bias corrected MLE)	5.537
nu hat (MLE)	428.3	nu star (bias corrected)	312.8
MLE Mean (bias corrected)	78.73	MLE Sd (bias corrected)	20.88
		Approximate Chi Square Value (0.05)	272.8
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	266.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	90.26	95% Adjusted Gamma UCL (use when n<50)	92.32

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.171	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.807	Mean of logged Data	4.34
Maximum of Logged Data	4.7	SD of logged Data	0.245

Assuming Lognormal Distribution

95% H-UCL	91.6	90% Chebyshev (MVUE) UCL	96.43
95% Chebyshev (MVUE) UCL	104.4	97.5% Chebyshev (MVUE) UCL	115.5
99% Chebyshev (MVUE) UCL	137.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	87.65	95% Jackknife UCL	88.56
95% Standard Bootstrap UCL	87.43	95% Bootstrap-t UCL	88.5
95% Hall's Bootstrap UCL	88.59	95% Percentile Bootstrap UCL	87
95% BCA Bootstrap UCL	87		
90% Chebyshev(Mean, Sd) UCL	95	95% Chebyshev(Mean, Sd) UCL	102.4
97.5% Chebyshev(Mean, Sd) UCL	112.6	99% Chebyshev(Mean, Sd) UCL	132.7

Suggested UCL to Use

95% Student's-t UCL 88.56

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Thallium (mg/kg)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	44
Number of Detects	59	Number of Non-Detects	25
Number of Distinct Detects	31	Number of Distinct Non-Detects	14
Minimum Detect	0.07	Minimum Non-Detect	0.24
Maximum Detect	5.3	Maximum Non-Detect	50
Variance Detects	0.885	Percent Non-Detects	29.76%
Mean Detects	0.525	SD Detects	0.941
Median Detects	0.23	CV Detects	1.792
Skewness Detects	3.723	Kurtosis Detects	14.37
Mean of Logged Detects	-1.22	SD of Logged Detects	0.847

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.438	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.405	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.115	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.501	KM Standard Error of Mean	0.11
KM SD	0.886	95% KM (BCA) UCL	0.698
95% KM (t) UCL	0.685	95% KM (Percentile Bootstrap) UCL	0.695
95% KM (z) UCL	0.683	95% KM Bootstrap t UCL	0.795
90% KM Chebyshev UCL	0.832	95% KM Chebyshev UCL	0.982
97.5% KM Chebyshev UCL	1.191	99% KM Chebyshev UCL	1.6

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	9.08	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.779	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.33	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.119	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.002	k star (bias corrected MLE)	0.962
Theta hat (MLE)	0.524	Theta star (bias corrected MLE)	0.546
nu hat (MLE)	118.2	nu star (bias corrected)	113.5
Mean (detects)	0.525		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.469
Maximum	5.3	Median	0.24
SD	0.819	CV	1.746
k hat (MLE)	0.894	k star (bias corrected MLE)	0.87
Theta hat (MLE)	0.525	Theta star (bias corrected MLE)	0.54
nu hat (MLE)	150.1	nu star (bias corrected)	146.1
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (146.11, α)	119.2	Adjusted Chi Square Value (146.11, β)	118.8
95% Gamma Approximate UCL (use when n>=50)	0.575	95% Gamma Adjusted UCL (use when n<50)	0.577

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.501	SD (KM)	0.886
Variance (KM)	0.785	SE of Mean (KM)	0.11
k hat (KM)	0.32	k star (KM)	0.316
nu hat (KM)	53.72	nu star (KM)	53.14
theta hat (KM)	1.567	theta star (KM)	1.584
80% gamma percentile (KM)	0.778	90% gamma percentile (KM)	1.468
95% gamma percentile (KM)	2.253	99% gamma percentile (KM)	4.281

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (53.14, α)	37.39	Adjusted Chi Square Value (53.14, β)	37.16
95% Gamma Approximate KM-UCL (use when n>=50)	0.712	95% Gamma Adjusted KM-UCL (use when n<50)	0.716

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.758	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.239E-12	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.46	Mean in Log Scale	-1.236
SD in Original Scale	0.797	SD in Log Scale	0.745
95% t UCL (assumes normality of ROS data)	0.605	95% Percentile Bootstrap UCL	0.612
95% BCA Bootstrap UCL	0.668	95% Bootstrap t UCL	0.691
95% H-UCL (Log ROS)	0.453		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.241	KM Geo Mean	0.289
KM SD (logged)	0.817	95% Critical H Value (KM-Log)	2.072
KM Standard Error of Mean (logged)	0.104	95% H-UCL (KM -Log)	0.486
KM SD (logged)	0.817	95% Critical H Value (KM-Log)	2.072
KM Standard Error of Mean (logged)	0.104		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.991	Mean in Log Scale	-0.341
SD in Original Scale	8.268	SD in Log Scale	1.725
95% t UCL (Assumes normality)	5.492	95% H-Stat UCL	5.586

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.982

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	6.16	Mean	51.5
Maximum	100	Median	57
SD	28.07	Std. Error of Mean	6.126
Coefficient of Variation	0.545	Skewness	-0.148

Normal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	62.06	95% Adjusted-CLT UCL (Chen-1995)	61.36
		95% Modified-t UCL (Johnson-1978)	62.03

Gamma GOF Test

A-D Test Statistic	0.841	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.752	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.191	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.372	k star (bias corrected MLE)	2.065
Theta hat (MLE)	21.71	Theta star (bias corrected MLE)	24.94
nu hat (MLE)	99.63	nu star (bias corrected)	86.73
MLE Mean (bias corrected)	51.5	MLE Sd (bias corrected)	35.84
		Approximate Chi Square Value (0.05)	66.26
Adjusted Level of Significance	0.0383	Adjusted Chi Square Value	64.89

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	67.41	95% Adjusted Gamma UCL (use when n<50)	68.83

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.908	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.201	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.188	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.818	Mean of logged Data	3.716
Maximum of Logged Data	4.605	SD of logged Data	0.794

Assuming Lognormal Distribution

95% H-UCL	84.8	90% Chebyshev (MVUE) UCL	86.51
95% Chebyshev (MVUE) UCL	100.7	97.5% Chebyshev (MVUE) UCL	120.3
99% Chebyshev (MVUE) UCL	158.8		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	61.58	95% Jackknife UCL	62.06
95% Standard Bootstrap UCL	61.33	95% Bootstrap-t UCL	61.87
95% Hall's Bootstrap UCL	61.35	95% Percentile Bootstrap UCL	60.82
95% BCA Bootstrap UCL	61.78		
90% Chebyshev(Mean, Sd) UCL	69.88	95% Chebyshev(Mean, Sd) UCL	78.2
97.5% Chebyshev(Mean, Sd) UCL	89.75	99% Chebyshev(Mean, Sd) UCL	112.5

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Student's-t UCL 62.06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Zinc (mg/kg)

General Statistics

Total Number of Observations	35	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	117	Mean	14518
Maximum	64400	Median	7900
SD	14839	Std. Error of Mean	2508
Coefficient of Variation	1.022	Skewness	1.502

Normal GOF Test

Shapiro Wilk Test Statistic	0.846	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.186	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.148	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	18760	95% Adjusted-CLT UCL (Chen-1995)	19324
		95% Modified-t UCL (Johnson-1978)	18866

Gamma GOF Test

A-D Test Statistic	0.455	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.789	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.101	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.155	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.741	k star (bias corrected MLE)	0.697
Theta hat (MLE)	19591	Theta star (bias corrected MLE)	20841
nu hat (MLE)	51.88	nu star (bias corrected)	48.76
MLE Mean (bias corrected)	14518	MLE Sd (bias corrected)	17395
		Approximate Chi Square Value (0.05)	33.73
Adjusted Level of Significance	0.0425	Adjusted Chi Square Value	33.14

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	20987	95% Adjusted Gamma UCL (use when n<50)	21363

Appendix D, Table 2. ProUCL Output - Tar Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.934	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.181	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.148	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.762	Mean of logged Data	8.774
Maximum of Logged Data	11.07	SD of logged Data	1.671

Assuming Lognormal Distribution

95% H-UCL	68825	90% Chebyshev (MVUE) UCL	50747
95% Chebyshev (MVUE) UCL	62890	97.5% Chebyshev (MVUE) UCL	79745
99% Chebyshev (MVUE) UCL	112852		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	18644	95% Jackknife UCL	18760
95% Standard Bootstrap UCL	18540	95% Bootstrap-t UCL	19735
95% Hall's Bootstrap UCL	19661	95% Percentile Bootstrap UCL	18667
95% BCA Bootstrap UCL	19152		
90% Chebyshev(Mean, Sd) UCL	22043	95% Chebyshev(Mean, Sd) UCL	25451
97.5% Chebyshev(Mean, Sd) UCL	30182	99% Chebyshev(Mean, Sd) UCL	39475

Suggested UCL to Use

95% Adjusted Gamma UCL 21363

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:22:14 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	18800	Mean	18800
Maximum	18800	Median	18800

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Aluminum (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	9.79	Mean	9.79
Maximum	9.79	Median	9.79

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Arsenic (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Barium (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	188	Mean	188
Maximum	188	Median	188

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Barium (mg/kg) was not processed!

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	1.32	Mean	1.32
Maximum	1.32	Median	1.32

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Beryllium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
Number of Detects	5	Number of Non-Detects	1
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	1.7	Minimum Non-Detect	0.926
Maximum Detect	6.2	Maximum Non-Detect	0.926
Variance Detects	4.013	Percent Non-Detects	16.67%
Mean Detects	3.34	SD Detects	2.003
Median Detects	2.1	CV Detects	0.6
Skewness Detects	0.891	Kurtosis Detects	-1.546
Mean of Logged Detects	1.068	SD of Logged Detects	0.578

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.332	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.938	KM Standard Error of Mean	0.852
KM SD	1.867	95% KM (BCA) UCL	4.321
95% KM (t) UCL	4.655	95% KM (Percentile Bootstrap) UCL	4.267
95% KM (z) UCL	4.339	95% KM Bootstrap t UCL	7.976
90% KM Chebyshev UCL	5.494	95% KM Chebyshev UCL	6.652
97.5% KM Chebyshev UCL	8.259	99% KM Chebyshev UCL	11.42

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.542	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.682	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.345	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.771	k star (bias corrected MLE)	1.642
Theta hat (MLE)	0.886	Theta star (bias corrected MLE)	2.034
nu hat (MLE)	37.71	nu star (bias corrected)	16.42
Mean (detects)	3.34		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.785
Maximum	6.2	Median	2.05
SD	2.249	CV	0.808
k hat (MLE)	0.674	k star (bias corrected MLE)	0.448
Theta hat (MLE)	4.135	Theta star (bias corrected MLE)	6.218
nu hat (MLE)	8.082	nu star (bias corrected)	5.375
Adjusted Level of Significance (β)	0.0122		
Approximate Chi Square Value (5.37, α)	1.329	Adjusted Chi Square Value (5.37, β)	0.736
95% Gamma Approximate UCL (use when n>=50)	11.26	95% Gamma Adjusted UCL (use when n<50)	20.32

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.938	SD (KM)	1.867
Variance (KM)	3.485	SE of Mean (KM)	0.852
k hat (KM)	2.477	k star (KM)	1.349
nu hat (KM)	29.72	nu star (KM)	16.19
theta hat (KM)	1.186	theta star (KM)	2.177
80% gamma percentile (KM)	4.597	90% gamma percentile (KM)	6.282
95% gamma percentile (KM)	7.931	99% gamma percentile (KM)	11.68

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (16.19, α)	8.098	Adjusted Chi Square Value (16.19, β)	6.146
95% Gamma Approximate KM-UCL (use when n>=50)	5.874	95% Gamma Adjusted KM-UCL (use when n<50)	7.739

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.85	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.313	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.898	Mean in Log Scale	0.828
SD in Original Scale	2.093	SD in Log Scale	0.783
95% t UCL (assumes normality of ROS data)	4.62	95% Percentile Bootstrap UCL	4.282
95% BCA Bootstrap UCL	4.333	95% Bootstrap t UCL	7.53
95% H-UCL (Log ROS)	10.31		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.877	KM Geo Mean	2.403
KM SD (logged)	0.636	95% Critical H Value (KM-Log)	2.991
KM Standard Error of Mean (logged)	0.29	95% H-UCL (KM -Log)	6.892
KM SD (logged)	0.636	95% Critical H Value (KM-Log)	2.991
KM Standard Error of Mean (logged)	0.29		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.861	Mean in Log Scale	0.761
SD in Original Scale	2.142	SD in Log Scale	0.911
95% t UCL (Assumes normality)	4.623	95% H-Stat UCL	15.29

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	4.655

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	23.7	Mean	23.7
Maximum	23.7	Median	23.7

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Chromium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Cobalt (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	15.1	Mean	15.1
Maximum	15.1	Median	15.1

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Cobalt (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Copper (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	14.6	Mean	14.6
Maximum	14.6	Median	14.6

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Copper (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Iron (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	26000	Mean	26000
Maximum	26000	Median	26000

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Iron (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lead (mg/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	14.1	Mean	37.83
Maximum	104	Median	26.75
SD	32.94	Std. Error of Mean	13.45
Coefficient of Variation	0.871	Skewness	2.27

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.668	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.407	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	64.93	95% Adjusted-CLT UCL (Chen-1995)	73.27
		95% Modified-t UCL (Johnson-1978)	67.01

Gamma GOF Test

A-D Test Statistic	0.74	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.703	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.353	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.335	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.436	k star (bias corrected MLE)	1.329
Theta hat (MLE)	15.53	Theta star (bias corrected MLE)	28.47
nu hat (MLE)	29.23	nu star (bias corrected)	15.95
MLE Mean (bias corrected)	37.83	MLE Sd (bias corrected)	32.82
		Approximate Chi Square Value (0.05)	7.925
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	5.998

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	76.13	95% Adjusted Gamma UCL (use when n<50)	100.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.308	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.325	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.646	Mean of logged Data	3.414
Maximum of Logged Data	4.644	SD of logged Data	0.664

Assuming Lognormal Distribution

95% H-UCL	94.11	90% Chebyshev (MVUE) UCL	65.76
95% Chebyshev (MVUE) UCL	79.09	97.5% Chebyshev (MVUE) UCL	97.59
99% Chebyshev (MVUE) UCL	133.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	59.95	95% Jackknife UCL	64.93
95% Standard Bootstrap UCL	58.03	95% Bootstrap-t UCL	154.4
95% Hall's Bootstrap UCL	198.4	95% Percentile Bootstrap UCL	62.62
95% BCA Bootstrap UCL	67.17		
90% Chebyshev(Mean, Sd) UCL	78.18	95% Chebyshev(Mean, Sd) UCL	96.45
97.5% Chebyshev(Mean, Sd) UCL	121.8	99% Chebyshev(Mean, Sd) UCL	171.6

Suggested UCL to Use

95% H-UCL 94.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Manganese (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	856	Mean	856
Maximum	856	Median	856

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Manganese (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nickel (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	24.9	Mean	24.9
Maximum	24.9	Median	24.9

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Nickel (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	40.8	Mean	40.8
Maximum	40.8	Median	40.8

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Vanadium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Zinc (mg/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	96.8	Mean	293
Maximum	478	Median	329.5
SD	168.8	Std. Error of Mean	68.9
Coefficient of Variation	0.576	Skewness	-0.283

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.859	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	431.8	95% Adjusted-CLT UCL (Chen-1995)	397.8
		95% Modified-t UCL (Johnson-1978)	430.5

Gamma GOF Test

A-D Test Statistic	0.573	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.702	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.286	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.335	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.779	k star (bias corrected MLE)	1.5
Theta hat (MLE)	105.4	Theta star (bias corrected MLE)	195.2
nu hat (MLE)	33.35	nu star (bias corrected)	18.01
MLE Mean (bias corrected)	293	MLE Sd (bias corrected)	239.2
		Approximate Chi Square Value (0.05)	9.395
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	7.261

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	561.5	95% Adjusted Gamma UCL (use when n<50)	726.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.816	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.325	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.573	Mean of logged Data	5.489
Maximum of Logged Data	6.17	SD of logged Data	0.729

Assuming Lognormal Distribution

95% H-UCL	914.4	90% Chebyshev (MVUE) UCL	566.9
95% Chebyshev (MVUE) UCL	687.7	97.5% Chebyshev (MVUE) UCL	855.3
99% Chebyshev (MVUE) UCL	1185		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	406.3	95% Jackknife UCL	431.8
95% Standard Bootstrap UCL	398.5	95% Bootstrap-t UCL	437.2
95% Hall's Bootstrap UCL	374	95% Percentile Bootstrap UCL	394.8
95% BCA Bootstrap UCL	392.1		
90% Chebyshev(Mean, Sd) UCL	499.7	95% Chebyshev(Mean, Sd) UCL	593.3
97.5% Chebyshev(Mean, Sd) UCL	723.3	99% Chebyshev(Mean, Sd) UCL	978.6

Appendix D, Table 3. ProUCL Output - Neosho River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Student's-t UCL 431.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:02:36 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	2870	Mean	10108
Maximum	17700	Median	10800
SD	4152	Std. Error of Mean	1072
Coefficient of Variation	0.411	Skewness	-0.346

Normal GOF Test

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.147	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	11996	95% Adjusted-CLT UCL (Chen-1995)	11769
		95% Modified-t UCL (Johnson-1978)	11980

Gamma GOF Test

A-D Test Statistic	0.759	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.739	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.202	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.657	k star (bias corrected MLE)	3.77
Theta hat (MLE)	2170	Theta star (bias corrected MLE)	2681
nu hat (MLE)	139.7	nu star (bias corrected)	113.1
MLE Mean (bias corrected)	10108	MLE Sd (bias corrected)	5206
		Approximate Chi Square Value (0.05)	89.55
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	86.97

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	12766	95% Adjusted Gamma UCL (use when n<50)	13145

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.845	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.216	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.962	Mean of logged Data	9.11
Maximum of Logged Data	9.781	SD of logged Data	0.54

Assuming Lognormal Distribution

95% H-UCL	14194	90% Chebyshev (MVUE) UCL	14831
95% Chebyshev (MVUE) UCL	16860	97.5% Chebyshev (MVUE) UCL	19676
99% Chebyshev (MVUE) UCL	25208		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	11871	95% Jackknife UCL	11996
95% Standard Bootstrap UCL	11827	95% Bootstrap-t UCL	11846
95% Hall's Bootstrap UCL	11780	95% Percentile Bootstrap UCL	11788
95% BCA Bootstrap UCL	11710		
90% Chebyshev(Mean, Sd) UCL	13324	95% Chebyshev(Mean, Sd) UCL	14781
97.5% Chebyshev(Mean, Sd) UCL	16803	99% Chebyshev(Mean, Sd) UCL	20775

Suggested UCL to Use

95% Student's-t UCL 11996

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Antimony (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	7
Number of Detects	4	Number of Non-Detects	11
Number of Distinct Detects	3	Number of Distinct Non-Detects	4
Minimum Detect	0.2	Minimum Non-Detect	1
Maximum Detect	1.2	Maximum Non-Detect	10.7
Variance Detects	0.197	Percent Non-Detects	73.33%
Mean Detects	0.55	SD Detects	0.443
Median Detects	0.4	CV Detects	0.806
Skewness Detects	1.72	Kurtosis Detects	3.265
Mean of Logged Detects	-0.815	SD of Logged Detects	0.741

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.8	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.382	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.478	KM Standard Error of Mean	0.161
KM SD	0.334	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.761	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.743	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.961	95% KM Chebyshev UCL	1.18
97.5% KM Chebyshev UCL	1.483	99% KM Chebyshev UCL	2.08

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.435	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.351	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.457	k star (bias corrected MLE)	0.781
Theta hat (MLE)	0.224	Theta star (bias corrected MLE)	0.704
nu hat (MLE)	19.66	nu star (bias corrected)	6.247
Mean (detects)	0.55		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.117	Mean	0.464
Maximum	1.2	Median	0.42
SD	0.292	CV	0.629
k hat (MLE)	2.992	k star (bias corrected MLE)	2.438
Theta hat (MLE)	0.155	Theta star (bias corrected MLE)	0.19
nu hat (MLE)	89.76	nu star (bias corrected)	73.14
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (73.14, α)	54.45	Adjusted Chi Square Value (73.14, β)	52.46
95% Gamma Approximate UCL (use when n>=50)	0.623	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.478	SD (KM)	0.334
Variance (KM)	0.112	SE of Mean (KM)	0.161
k hat (KM)	2.043	k star (KM)	1.679
nu hat (KM)	61.29	nu star (KM)	50.37
theta hat (KM)	0.234	theta star (KM)	0.285
80% gamma percentile (KM)	0.73	90% gamma percentile (KM)	0.969
95% gamma percentile (KM)	1.199	99% gamma percentile (KM)	1.715

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (50.37, α)	35.07	Adjusted Chi Square Value (50.37, β)	33.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.686	95% Gamma Adjusted KM-UCL (use when n<50)	0.718

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.304	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.45	Mean in Log Scale	-0.934
SD in Original Scale	0.27	SD in Log Scale	0.522
95% t UCL (assumes normality of ROS data)	0.573	95% Percentile Bootstrap UCL	0.574
95% BCA Bootstrap UCL	0.587	95% Bootstrap t UCL	0.644
95% H-UCL (Log ROS)	0.603		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.926	KM Geo Mean	0.396
KM SD (logged)	0.578	95% Critical H Value (KM-Log)	2.155
KM Standard Error of Mean (logged)	0.296	95% H-UCL (KM -Log)	0.654
KM SD (logged)	0.578	95% Critical H Value (KM-Log)	2.155
KM Standard Error of Mean (logged)	0.296		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.403	Mean in Log Scale	-0.0147
SD in Original Scale	1.34	SD in Log Scale	0.87
95% t UCL (Assumes normality)	2.013	95% H-Stat UCL	2.599

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.761

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Arsenic (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	5	Mean	18.91
Maximum	49.9	Median	13
SD	13.62	Std. Error of Mean	3.517
Coefficient of Variation	0.721	Skewness	1.115

Normal GOF Test

Shapiro Wilk Test Statistic	0.876	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.201	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	25.1	95% Adjusted-CLT UCL (Chen-1995)	25.77
		95% Modified-t UCL (Johnson-1978)	25.27

Gamma GOF Test

A-D Test Statistic	0.313	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.15	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.24	k star (bias corrected MLE)	1.837
Theta hat (MLE)	8.439	Theta star (bias corrected MLE)	10.29
nu hat (MLE)	67.21	nu star (bias corrected)	55.1
MLE Mean (bias corrected)	18.91	MLE Sd (bias corrected)	13.95
		Approximate Chi Square Value (0.05)	39.04
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	37.38

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	26.68	95% Adjusted Gamma UCL (use when n<50)	27.87

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.609	Mean of logged Data	2.7
Maximum of Logged Data	3.91	SD of logged Data	0.725

Assuming Lognormal Distribution

95% H-UCL	30.47	90% Chebyshev (MVUE) UCL	30.21
95% Chebyshev (MVUE) UCL	35.32	97.5% Chebyshev (MVUE) UCL	42.39
99% Chebyshev (MVUE) UCL	56.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	24.69	95% Jackknife UCL	25.1
95% Standard Bootstrap UCL	24.39	95% Bootstrap-t UCL	27.52
95% Hall's Bootstrap UCL	27.54	95% Percentile Bootstrap UCL	24.9
95% BCA Bootstrap UCL	25.65		
90% Chebyshev(Mean, Sd) UCL	29.46	95% Chebyshev(Mean, Sd) UCL	34.24
97.5% Chebyshev(Mean, Sd) UCL	40.87	99% Chebyshev(Mean, Sd) UCL	53.9

Suggested UCL to Use

95% Student's-t UCL 25.1

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	44.7	Mean	142.5
Maximum	216	Median	139
SD	51.83	Std. Error of Mean	13.38
Coefficient of Variation	0.364	Skewness	-0.255

Normal GOF Test

Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.111	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	166.1	95% Adjusted-CLT UCL (Chen-1995)	163.6
		95% Modified-t UCL (Johnson-1978)	165.9

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	0.339	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.131	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.547	k star (bias corrected MLE)	5.282
Theta hat (MLE)	21.76	Theta star (bias corrected MLE)	26.98
nu hat (MLE)	196.4	nu star (bias corrected)	158.5
MLE Mean (bias corrected)	142.5	MLE Sd (bias corrected)	62
		Approximate Chi Square Value (0.05)	130.4
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	127.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	173.2	95% Adjusted Gamma UCL (use when n<50)	177.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.8	Mean of logged Data	4.881
Maximum of Logged Data	5.375	SD of logged Data	0.441

Assuming Lognormal Distribution

95% H-UCL	183.9	90% Chebyshev (MVUE) UCL	194.6
95% Chebyshev (MVUE) UCL	217.4	97.5% Chebyshev (MVUE) UCL	249.1
99% Chebyshev (MVUE) UCL	311.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	164.5	95% Jackknife UCL	166.1
95% Standard Bootstrap UCL	163.8	95% Bootstrap-t UCL	165.4
95% Hall's Bootstrap UCL	162.9	95% Percentile Bootstrap UCL	163.9
95% BCA Bootstrap UCL	165.8		
90% Chebyshev(Mean, Sd) UCL	182.6	95% Chebyshev(Mean, Sd) UCL	200.8
97.5% Chebyshev(Mean, Sd) UCL	226.1	99% Chebyshev(Mean, Sd) UCL	275.7

Suggested UCL to Use

95% Student's-t UCL 166.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	8
Number of Detects	14	Number of Non-Detects	1
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.7	Minimum Non-Detect	2
Maximum Detect	2	Maximum Non-Detect	2
Variance Detects	0.115	Percent Non-Detects	6.667%
Mean Detects	0.999	SD Detects	0.34
Median Detects	0.9	CV Detects	0.34
Skewness Detects	2.259	Kurtosis Detects	5.803
Mean of Logged Detects	-0.0416	SD of Logged Detects	0.28

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.744	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.994	KM Standard Error of Mean	0.0868
KM SD	0.32	95% KM (BCA) UCL	1.147
95% KM (t) UCL	1.147	95% KM (Percentile Bootstrap) UCL	1.147
95% KM (z) UCL	1.137	95% KM Bootstrap t UCL	1.315
90% KM Chebyshev UCL	1.255	95% KM Chebyshev UCL	1.373
97.5% KM Chebyshev UCL	1.536	99% KM Chebyshev UCL	1.858

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.896	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.734	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.247	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.229	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	12.36	k star (bias corrected MLE)	9.759
Theta hat (MLE)	0.0809	Theta star (bias corrected MLE)	0.102
nu hat (MLE)	346.1	nu star (bias corrected)	273.3
Mean (detects)	0.999		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum	0.7	Mean	0.995
Maximum	2	Median	0.9
SD	0.328	CV	0.329
k hat (MLE)	13.19	k star (bias corrected MLE)	10.6
Theta hat (MLE)	0.0755	Theta star (bias corrected MLE)	0.0939
nu hat (MLE)	395.7	nu star (bias corrected)	317.9
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (317.93, α)	277.6	Adjusted Chi Square Value (317.93, β)	273
95% Gamma Approximate UCL (use when n>=50)	1.14	95% Gamma Adjusted UCL (use when n<50)	1.159

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.994	SD (KM)	0.32
Variance (KM)	0.103	SE of Mean (KM)	0.0868
k hat (KM)	9.642	k star (KM)	7.758
nu hat (KM)	289.3	nu star (KM)	232.7
theta hat (KM)	0.103	theta star (KM)	0.128
80% gamma percentile (KM)	1.276	90% gamma percentile (KM)	1.47
95% gamma percentile (KM)	1.645	99% gamma percentile (KM)	2.007

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (232.74, α)	198.4	Adjusted Chi Square Value (232.74, β)	194.5
95% Gamma Approximate KM-UCL (use when n>=50)	1.166	95% Gamma Adjusted KM-UCL (use when n<50)	1.19

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.86	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.227	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.995	Mean in Log Scale	-0.0436
SD in Original Scale	0.328	SD in Log Scale	0.269
95% t UCL (assumes normality of ROS data)	1.144	95% Percentile Bootstrap UCL	1.142
95% BCA Bootstrap UCL	1.188	95% Bootstrap t UCL	1.3
95% H-UCL (Log ROS)	1.135		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.0453	KM Geo Mean	0.956
KM SD (logged)	0.265	95% Critical H Value (KM-Log)	1.855
KM Standard Error of Mean (logged)	0.0722	95% H-UCL (KM -Log)	1.129
KM SD (logged)	0.265	95% Critical H Value (KM-Log)	1.855
KM Standard Error of Mean (logged)	0.0722		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.999	Mean in Log Scale	-0.0388
SD in Original Scale	0.327	SD in Log Scale	0.27
95% t UCL (Assumes normality)	1.148	95% H-Stat UCL	1.14

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.147	KM H-UCL	1.129
95% KM (BCA) UCL	1.147		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	2.4	Mean	38.69
Maximum	237	Median	24.95
SD	54.74	Std. Error of Mean	13.69
Coefficient of Variation	1.415	Skewness	3.551

Normal GOF Test

Shapiro Wilk Test Statistic	0.517	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.382	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	62.68	95% Adjusted-CLT UCL (Chen-1995)	74.18
		95% Modified-t UCL (Johnson-1978)	64.71

Gamma GOF Test

A-D Test Statistic	0.825	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.242	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.221	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.093	k star (bias corrected MLE)	0.93
Theta hat (MLE)	35.39	Theta star (bias corrected MLE)	41.61
nu hat (MLE)	34.98	nu star (bias corrected)	29.76
MLE Mean (bias corrected)	38.69	MLE Sd (bias corrected)	40.12
		Approximate Chi Square Value (0.05)	18.3
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	17.28

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	62.91	95% Adjusted Gamma UCL (use when n<50)	66.62

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.199	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.875	Mean of logged Data	3.133
Maximum of Logged Data	5.468	SD of logged Data	1.06

Assuming Lognormal Distribution

95% H-UCL	86.58	90% Chebyshev (MVUE) UCL	71.96
95% Chebyshev (MVUE) UCL	87.22	97.5% Chebyshev (MVUE) UCL	108.4
99% Chebyshev (MVUE) UCL	150		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	61.2	95% Jackknife UCL	62.68
95% Standard Bootstrap UCL	60.19	95% Bootstrap-t UCL	107.1
95% Hall's Bootstrap UCL	151.7	95% Percentile Bootstrap UCL	64.43
95% BCA Bootstrap UCL	79.49		
90% Chebyshev(Mean, Sd) UCL	79.75	95% Chebyshev(Mean, Sd) UCL	98.35
97.5% Chebyshev(Mean, Sd) UCL	124.2	99% Chebyshev(Mean, Sd) UCL	174.9

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	98.35

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	13	Mean	27.15
Maximum	120	Median	20
SD	26.39	Std. Error of Mean	6.814
Coefficient of Variation	0.972	Skewness	3.537

Normal GOF Test

Shapiro Wilk Test Statistic	0.488	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.366	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	39.15	95% Adjusted-CLT UCL (Chen-1995)	45
		95% Modified-t UCL (Johnson-1978)	40.18

Gamma GOF Test

A-D Test Statistic	1.704	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.284	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.224	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.645	k star (bias corrected MLE)	2.16
Theta hat (MLE)	10.26	Theta star (bias corrected MLE)	12.57
nu hat (MLE)	79.34	nu star (bias corrected)	64.81
MLE Mean (bias corrected)	27.15	MLE Sd (bias corrected)	18.47
		Approximate Chi Square Value (0.05)	47.28
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	45.44

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	37.21	95% Adjusted Gamma UCL (use when n<50)	38.71

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.771	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.222	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.565	Mean of logged Data	3.1
Maximum of Logged Data	4.787	SD of logged Data	0.546

Assuming Lognormal Distribution

95% H-UCL	35.13	90% Chebyshev (MVUE) UCL	36.67
95% Chebyshev (MVUE) UCL	41.73	97.5% Chebyshev (MVUE) UCL	48.75
99% Chebyshev (MVUE) UCL	62.55		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	38.35	95% Jackknife UCL	39.15
95% Standard Bootstrap UCL	38.16	95% Bootstrap-t UCL	72.71
95% Hall's Bootstrap UCL	85.59	95% Percentile Bootstrap UCL	39.53
95% BCA Bootstrap UCL	46.69		
90% Chebyshev(Mean, Sd) UCL	47.59	95% Chebyshev(Mean, Sd) UCL	56.85
97.5% Chebyshev(Mean, Sd) UCL	69.7	99% Chebyshev(Mean, Sd) UCL	94.94

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	56.85

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	6	Mean	17.61
Maximum	38	Median	13
SD	9.816	Std. Error of Mean	2.535
Coefficient of Variation	0.557	Skewness	0.816

Normal GOF Test

Shapiro Wilk Test Statistic	0.9	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.214	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	22.08	95% Adjusted-CLT UCL (Chen-1995)	22.35
		95% Modified-t UCL (Johnson-1978)	22.17

Gamma GOF Test

A-D Test Statistic	0.414	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.177	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.223	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.601	k star (bias corrected MLE)	2.926
Theta hat (MLE)	4.891	Theta star (bias corrected MLE)	6.021
nu hat (MLE)	108	nu star (bias corrected)	87.77
MLE Mean (bias corrected)	17.61	MLE Sd (bias corrected)	10.3
		Approximate Chi Square Value (0.05)	67.17
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	64.95

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	23.01	95% Adjusted Gamma UCL (use when n<50)	23.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.144	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal Statistics

Minimum of Logged Data	1.792	Mean of logged Data	2.723
Maximum of Logged Data	3.638	SD of logged Data	0.563

Assuming Lognormal Distribution

95% H-UCL	24.63	90% Chebyshev (MVUE) UCL	25.63
95% Chebyshev (MVUE) UCL	29.24	97.5% Chebyshev (MVUE) UCL	34.26
99% Chebyshev (MVUE) UCL	44.12		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	21.78	95% Jackknife UCL	22.08
95% Standard Bootstrap UCL	21.71	95% Bootstrap-t UCL	23.11
95% Hall's Bootstrap UCL	22.44	95% Percentile Bootstrap UCL	22.07
95% BCA Bootstrap UCL	21.95		
90% Chebyshev(Mean, Sd) UCL	25.22	95% Chebyshev(Mean, Sd) UCL	28.66
97.5% Chebyshev(Mean, Sd) UCL	33.44	99% Chebyshev(Mean, Sd) UCL	42.83

Suggested UCL to Use

95% Student's-t UCL 22.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	6	Mean	13.07
Maximum	21	Median	13
SD	4.008	Std. Error of Mean	1.035
Coefficient of Variation	0.307	Skewness	0.466

Normal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	14.89	95% Adjusted-CLT UCL (Chen-1995)	14.9
		95% Modified-t UCL (Johnson-1978)	14.91

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	0.232	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.737	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.107	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.221	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.09	k star (bias corrected MLE)	8.916
Theta hat (MLE)	1.178	Theta star (bias corrected MLE)	1.466
nu hat (MLE)	332.7	nu star (bias corrected)	267.5
MLE Mean (bias corrected)	13.07	MLE Sd (bias corrected)	4.376
		Approximate Chi Square Value (0.05)	230.6
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	226.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	15.16	95% Adjusted Gamma UCL (use when n<50)	15.44

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.118	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.792	Mean of logged Data	2.524
Maximum of Logged Data	3.045	SD of logged Data	0.32

Assuming Lognormal Distribution

95% H-UCL	15.45	90% Chebyshev (MVUE) UCL	16.38
95% Chebyshev (MVUE) UCL	17.86	97.5% Chebyshev (MVUE) UCL	19.93
99% Chebyshev (MVUE) UCL	23.99		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	14.77	95% Jackknife UCL	14.89
95% Standard Bootstrap UCL	14.74	95% Bootstrap-t UCL	15.07
95% Hall's Bootstrap UCL	15.17	95% Percentile Bootstrap UCL	14.67
95% BCA Bootstrap UCL	14.87		
90% Chebyshev(Mean, Sd) UCL	16.17	95% Chebyshev(Mean, Sd) UCL	17.58
97.5% Chebyshev(Mean, Sd) UCL	19.53	99% Chebyshev(Mean, Sd) UCL	23.36

Suggested UCL to Use

95% Student's-t UCL	14.89

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Iron (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	12800	Mean	25720
Maximum	86900	Median	21200
SD	18591	Std. Error of Mean	4800
Coefficient of Variation	0.723	Skewness	2.886

Normal GOF Test

Shapiro Wilk Test Statistic	0.638	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.322	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	34175	95% Adjusted-CLT UCL (Chen-1995)	37438
		95% Modified-t UCL (Johnson-1978)	34771

Gamma GOF Test

A-D Test Statistic	0.966	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.239	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.223	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.58	k star (bias corrected MLE)	2.908
Theta hat (MLE)	7184	Theta star (bias corrected MLE)	8843
nu hat (MLE)	107.4	nu star (bias corrected)	87.25
MLE Mean (bias corrected)	25720	MLE Sd (bias corrected)	15081
		Approximate Chi Square Value (0.05)	66.72
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	64.51

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	33636	95% Adjusted Gamma UCL (use when n<50)	34787

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.195	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.457	Mean of logged Data	10.01
Maximum of Logged Data	11.37	SD of logged Data	0.502

Assuming Lognormal Distribution

95% H-UCL	33282	90% Chebyshev (MVUE) UCL	34984
95% Chebyshev (MVUE) UCL	39517	97.5% Chebyshev (MVUE) UCL	45809
99% Chebyshev (MVUE) UCL	58167		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	33616	95% Jackknife UCL	34175
95% Standard Bootstrap UCL	33492	95% Bootstrap-t UCL	48396
95% Hall's Bootstrap UCL	70374	95% Percentile Bootstrap UCL	34233
95% BCA Bootstrap UCL	37167		
90% Chebyshev(Mean, Sd) UCL	40121	95% Chebyshev(Mean, Sd) UCL	46644
97.5% Chebyshev(Mean, Sd) UCL	55698	99% Chebyshev(Mean, Sd) UCL	73482

Suggested UCL to Use

95% H-UCL 33282

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Lead (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	47.2	Mean	274.7
Maximum	877	Median	208
SD	203.8	Std. Error of Mean	50.96
Coefficient of Variation	0.742	Skewness	1.913

Normal GOF Test

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.179	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	364	95% Adjusted-CLT UCL (Chen-1995)	384.5
		95% Modified-t UCL (Johnson-1978)	368

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	0.254	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.111	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.217	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.374	k star (bias corrected MLE)	1.97
Theta hat (MLE)	115.7	Theta star (bias corrected MLE)	139.4
nu hat (MLE)	75.96	nu star (bias corrected)	63.05
MLE Mean (bias corrected)	274.7	MLE Sd (bias corrected)	195.7
		Approximate Chi Square Value (0.05)	45.79
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	44.11

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	378.2	95% Adjusted Gamma UCL (use when n<50)	392.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.983	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.854	Mean of logged Data	5.39
Maximum of Logged Data	6.777	SD of logged Data	0.706

Assuming Lognormal Distribution

95% H-UCL	426.7	90% Chebyshev (MVUE) UCL	430.7
95% Chebyshev (MVUE) UCL	500.7	97.5% Chebyshev (MVUE) UCL	597.9
99% Chebyshev (MVUE) UCL	788.8		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	358.5	95% Jackknife UCL	364
95% Standard Bootstrap UCL	355.4	95% Bootstrap-t UCL	427.4
95% Hall's Bootstrap UCL	775.9	95% Percentile Bootstrap UCL	365.2
95% BCA Bootstrap UCL	388.6		
90% Chebyshev(Mean, Sd) UCL	427.5	95% Chebyshev(Mean, Sd) UCL	496.8
97.5% Chebyshev(Mean, Sd) UCL	592.9	99% Chebyshev(Mean, Sd) UCL	781.7

Suggested UCL to Use

95% Student's-t UCL 364

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	178	Mean	1349
Maximum	4630	Median	880
SD	1335	Std. Error of Mean	344.6
Coefficient of Variation	0.99	Skewness	1.559

Normal GOF Test

Shapiro Wilk Test Statistic	0.777	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1956	95% Adjusted-CLT UCL (Chen-1995)	2064
		95% Modified-t UCL (Johnson-1978)	1979

Gamma GOF Test

A-D Test Statistic	0.484	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.171	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.226	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.332	k star (bias corrected MLE)	1.11
Theta hat (MLE)	1012	Theta star (bias corrected MLE)	1215
nu hat (MLE)	39.97	nu star (bias corrected)	33.31
MLE Mean (bias corrected)	1349	MLE Sd (bias corrected)	1280
		Approximate Chi Square Value (0.05)	21.11
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	19.92

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2128	95% Adjusted Gamma UCL (use when n<50)	2255

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal Statistics

Minimum of Logged Data	5.182	Mean of logged Data	6.787
Maximum of Logged Data	8.44	SD of logged Data	0.961

Assuming Lognormal Distribution

95% H-UCL	2799	90% Chebyshev (MVUE) UCL	2440
95% Chebyshev (MVUE) UCL	2934	97.5% Chebyshev (MVUE) UCL	3621
99% Chebyshev (MVUE) UCL	4969		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1915	95% Jackknife UCL	1956
95% Standard Bootstrap UCL	1895	95% Bootstrap-t UCL	2289
95% Hall's Bootstrap UCL	1975	95% Percentile Bootstrap UCL	1929
95% BCA Bootstrap UCL	2052		
90% Chebyshev(Mean, Sd) UCL	2382	95% Chebyshev(Mean, Sd) UCL	2851
97.5% Chebyshev(Mean, Sd) UCL	3501	99% Chebyshev(Mean, Sd) UCL	4777

Suggested UCL to Use

95% Adjusted Gamma UCL 2255

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	7
Number of Detects	7	Number of Non-Detects	7
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	0.05	Minimum Non-Detect	0.3
Maximum Detect	0.19	Maximum Non-Detect	0.3
Variance Detects	0.00318	Percent Non-Detects	50%
Mean Detects	0.111	SD Detects	0.0564
Median Detects	0.12	CV Detects	0.506
Skewness Detects	0.246	Kurtosis Detects	-1.792
Mean of Logged Detects	-2.317	SD of Logged Detects	0.547

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.248	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.111	KM Standard Error of Mean	0.0213
KM SD	0.0522	95% KM (BCA) UCL	0.145
95% KM (t) UCL	0.149	95% KM (Percentile Bootstrap) UCL	0.145
95% KM (z) UCL	0.146	95% KM Bootstrap t UCL	0.158
90% KM Chebyshev UCL	0.175	95% KM Chebyshev UCL	0.204
97.5% KM Chebyshev UCL	0.245	99% KM Chebyshev UCL	0.324

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.474	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.71	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.267	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.253	k star (bias corrected MLE)	2.525
Theta hat (MLE)	0.0262	Theta star (bias corrected MLE)	0.0441
nu hat (MLE)	59.54	nu star (bias corrected)	35.35
Mean (detects)	0.111		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0414	Mean	0.111
Maximum	0.199	Median	0.113
SD	0.0533	CV	0.479
k hat (MLE)	4.377	k star (bias corrected MLE)	3.486
Theta hat (MLE)	0.0255	Theta star (bias corrected MLE)	0.032
nu hat (MLE)	122.5	nu star (bias corrected)	97.62
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (97.62, α)	75.83	Adjusted Chi Square Value (97.62, β)	73.29
95% Gamma Approximate UCL (use when n>=50)	0.143	95% Gamma Adjusted UCL (use when n<50)	0.148

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.111	SD (KM)	0.0522
Variance (KM)	0.00273	SE of Mean (KM)	0.0213
k hat (KM)	4.554	k star (KM)	3.626
nu hat (KM)	127.5	nu star (KM)	101.5
theta hat (KM)	0.0245	theta star (KM)	0.0307
80% gamma percentile (KM)	0.155	90% gamma percentile (KM)	0.19
95% gamma percentile (KM)	0.222	99% gamma percentile (KM)	0.29

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (101.52, α)	79.27	Adjusted Chi Square Value (101.52, β)	76.67
95% Gamma Approximate KM-UCL (use when n>=50)	0.143	95% Gamma Adjusted KM-UCL (use when n<50)	0.148

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.878	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.247	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.111	Mean in Log Scale	-2.317
SD in Original Scale	0.0545	SD in Log Scale	0.514
95% t UCL (assumes normality of ROS data)	0.137	95% Percentile Bootstrap UCL	0.135
95% BCA Bootstrap UCL	0.136	95% Bootstrap t UCL	0.14
95% H-UCL (Log ROS)	0.15		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.317	KM Geo Mean	0.0986
KM SD (logged)	0.507	95% Critical H Value (KM-Log)	2.016
KM Standard Error of Mean (logged)	0.207	95% H-UCL (KM -Log)	0.149
KM SD (logged)	0.507	95% Critical H Value (KM-Log)	2.016
KM Standard Error of Mean (logged)	0.207		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.131	Mean in Log Scale	-2.107
SD in Original Scale	0.0432	SD in Log Scale	0.431
95% t UCL (Assumes normality)	0.151	95% H-Stat UCL	0.169

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.149

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	5
Number of Detects	9	Number of Non-Detects	5
Number of Distinct Detects	4	Number of Distinct Non-Detects	2
Minimum Detect	1	Minimum Non-Detect	5
Maximum Detect	5	Maximum Non-Detect	50
Variance Detects	2.5	Percent Non-Detects	35.71%
Mean Detects	2.667	SD Detects	1.581
Median Detects	2	CV Detects	0.593
Skewness Detects	0.705	Kurtosis Detects	-1.2
Mean of Logged Detects	0.82	SD of Logged Detects	0.61

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.819	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.33	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.462	KM Standard Error of Mean	0.447
KM SD	1.377	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.254	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.197	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	3.803	95% KM Chebyshev UCL	4.411
97.5% KM Chebyshev UCL	5.255	99% KM Chebyshev UCL	6.911

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.656	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.726	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.287	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.281	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.261	k star (bias corrected MLE)	2.248
Theta hat (MLE)	0.818	Theta star (bias corrected MLE)	1.186
nu hat (MLE)	58.7	nu star (bias corrected)	40.47
Mean (detects)	2.667		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1	Mean	2.447
Maximum	5	Median	2
SD	1.334	CV	0.545
k hat (MLE)	4.013	k star (bias corrected MLE)	3.201
Theta hat (MLE)	0.61	Theta star (bias corrected MLE)	0.765
nu hat (MLE)	112.4	nu star (bias corrected)	89.62
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (89.62, α)	68.79	Adjusted Chi Square Value (89.62, β)	66.37
95% Gamma Approximate UCL (use when n>=50)	3.188	95% Gamma Adjusted UCL (use when n<50)	3.304

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.462	SD (KM)	1.377
Variance (KM)	1.897	SE of Mean (KM)	0.447
k hat (KM)	3.194	k star (KM)	2.557
nu hat (KM)	89.44	nu star (KM)	71.61
theta hat (KM)	0.771	theta star (KM)	0.963
80% gamma percentile (KM)	3.579	90% gamma percentile (KM)	4.524
95% gamma percentile (KM)	5.413	99% gamma percentile (KM)	7.358

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (71.61, α)	53.12	Adjusted Chi Square Value (71.61, β)	51.02
95% Gamma Approximate KM-UCL (use when n>=50)	3.318	95% Gamma Adjusted KM-UCL (use when n<50)	3.455

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.249	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.41	Mean in Log Scale	0.75
SD in Original Scale	1.333	SD in Log Scale	0.521
95% t UCL (assumes normality of ROS data)	3.041	95% Percentile Bootstrap UCL	3.011
95% BCA Bootstrap UCL	3.071	95% Bootstrap t UCL	3.389
95% H-UCL (Log ROS)	3.254		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.75	KM Geo Mean	2.118
KM SD (logged)	0.548	95% Critical H Value (KM-Log)	2.081
KM Standard Error of Mean (logged)	0.185	95% H-UCL (KM -Log)	3.376
KM SD (logged)	0.548	95% Critical H Value (KM-Log)	2.081
KM Standard Error of Mean (logged)	0.185		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	4.214	Mean in Log Scale	1.019
SD in Original Scale	6.11	SD in Log Scale	0.795
95% t UCL (Assumes normality)	7.106	95% H-Stat UCL	6.551

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	3.455	95% GROS Adjusted Gamma UCL	3.304

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Nickel (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	9	Mean	26.21
Maximum	60	Median	19
SD	16.64	Std. Error of Mean	4.297
Coefficient of Variation	0.635	Skewness	0.784

Normal GOF Test

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.201	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	33.78	95% Adjusted-CLT UCL (Chen-1995)	34.21
		95% Modified-t UCL (Johnson-1978)	33.93

Gamma GOF Test

A-D Test Statistic	0.438	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.15	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.733	k star (bias corrected MLE)	2.231
Theta hat (MLE)	9.59	Theta star (bias corrected MLE)	11.75
nu hat (MLE)	82	nu star (bias corrected)	66.93
MLE Mean (bias corrected)	26.21	MLE Sd (bias corrected)	17.55
		Approximate Chi Square Value (0.05)	49.11
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	47.23

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	35.73	95% Adjusted Gamma UCL (use when n<50)	37.15

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.142	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.197	Mean of logged Data	3.072
Maximum of Logged Data	4.094	SD of logged Data	0.653

Assuming Lognormal Distribution

95% H-UCL	39.55	90% Chebyshev (MVUE) UCL	40.22
95% Chebyshev (MVUE) UCL	46.53	97.5% Chebyshev (MVUE) UCL	55.3
99% Chebyshev (MVUE) UCL	72.51		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	33.28	95% Jackknife UCL	33.78
95% Standard Bootstrap UCL	32.94	95% Bootstrap-t UCL	34.91
95% Hall's Bootstrap UCL	33.59	95% Percentile Bootstrap UCL	33.24
95% BCA Bootstrap UCL	33.95		
90% Chebyshev(Mean, Sd) UCL	39.1	95% Chebyshev(Mean, Sd) UCL	44.94
97.5% Chebyshev(Mean, Sd) UCL	53.05	99% Chebyshev(Mean, Sd) UCL	68.96

Suggested UCL to Use

95% Student's-t UCL 33.78

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	5
Number of Detects	2	Number of Non-Detects	13
Number of Distinct Detects	2	Number of Distinct Non-Detects	3
Minimum Detect	0.7	Minimum Non-Detect	3
Maximum Detect	0.8	Maximum Non-Detect	6.24
Variance Detects	0.005	Percent Non-Detects	86.67%
Mean Detects	0.75	SD Detects	0.0707
Median Detects	0.75	CV Detects	0.0943
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.29	SD of Logged Detects	0.0944

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.75	KM Standard Error of Mean	0.05
KM SD	0.05	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.838	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.832	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.9	95% KM Chebyshev UCL	0.968
97.5% KM Chebyshev UCL	1.062	99% KM Chebyshev UCL	1.247

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	224.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00334	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	898.7	nu star (bias corrected)	N/A
Mean (detects)	0.75		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.75	SD (KM)	0.05
Variance (KM)	0.0025	SE of Mean (KM)	0.05
k hat (KM)	225	k star (KM)	180
nu hat (KM)	6750	nu star (KM)	5401
theta hat (KM)	0.00333	theta star (KM)	0.00417
80% gamma percentile (KM)	0.797	90% gamma percentile (KM)	0.822
95% gamma percentile (KM)	0.844	99% gamma percentile (KM)	0.886

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0324
Approximate Chi Square Value (N/A, α)	5232	Adjusted Chi Square Value (N/A, β)	5211
95% Gamma Approximate KM-UCL (use when n>=50)	0.774	95% Gamma Adjusted KM-UCL (use when n<50)	0.777

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.752	Mean in Log Scale	-0.29
SD in Original Scale	0.0787	SD in Log Scale	0.105
95% t UCL (assumes normality of ROS data)	0.788	95% Percentile Bootstrap UCL	0.783
95% BCA Bootstrap UCL	0.785	95% Bootstrap t UCL	0.789
95% H-UCL (Log ROS)	0.79		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.29	KM Geo Mean	0.748
KM SD (logged)	0.0668	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0668	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.0668	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0668		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.975	Mean in Log Scale	0.6
SD in Original Scale	0.726	SD in Log Scale	0.445
95% t UCL (Assumes normality)	2.305	95% H-Stat UCL	2.555

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.838	KM H-UCL	N/A
95% KM (BCA) UCL	N/A		

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Warning: One or more Recommended UCL(s) not available!
Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silica (as SIO2) (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	2430	Mean	5346
Maximum	7290	Median	5655
SD	1465	Std. Error of Mean	391.6
Coefficient of Variation	0.274	Skewness	-0.477

Normal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.135	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6039	95% Adjusted-CLT UCL (Chen-1995)	5937
		95% Modified-t UCL (Johnson-1978)	6031

Gamma GOF Test

A-D Test Statistic	0.424	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.164	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.229	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.2	k star (bias corrected MLE)	9.633
Theta hat (MLE)	438.2	Theta star (bias corrected MLE)	555
nu hat (MLE)	341.6	nu star (bias corrected)	269.7
MLE Mean (bias corrected)	5346	MLE Sd (bias corrected)	1722
		Approximate Chi Square Value (0.05)	232.7
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	228.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6197	95% Adjusted Gamma UCL (use when n<50)	6320

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.18	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.796	Mean of logged Data	8.543
Maximum of Logged Data	8.894	SD of logged Data	0.314

Assuming Lognormal Distribution

95% H-UCL	6363	90% Chebyshev (MVUE) UCL	6738
95% Chebyshev (MVUE) UCL	7358	97.5% Chebyshev (MVUE) UCL	8219
99% Chebyshev (MVUE) UCL	9910		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5990	95% Jackknife UCL	6039
95% Standard Bootstrap UCL	5952	95% Bootstrap-t UCL	5991
95% Hall's Bootstrap UCL	5938	95% Percentile Bootstrap UCL	5969
95% BCA Bootstrap UCL	5916		
90% Chebyshev(Mean, Sd) UCL	6521	95% Chebyshev(Mean, Sd) UCL	7053
97.5% Chebyshev(Mean, Sd) UCL	7791	99% Chebyshev(Mean, Sd) UCL	9242

Suggested UCL to Use

95% Student's-t UCL 6039

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Silver (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	11
Number of Detects	14	Number of Non-Detects	1
Number of Distinct Detects	10	Number of Distinct Non-Detects	1
Minimum Detect	0.06	Minimum Non-Detect	1.78
Maximum Detect	0.8	Maximum Non-Detect	1.78
Variance Detects	0.0352	Percent Non-Detects	6.667%
Mean Detects	0.154	SD Detects	0.188
Median Detects	0.1	CV Detects	1.216
Skewness Detects	3.616	Kurtosis Detects	13.32
Mean of Logged Detects	-2.141	SD of Logged Detects	0.607

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.426	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.416	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.154	KM Standard Error of Mean	0.0502
KM SD	0.181	95% KM (BCA) UCL	0.26
95% KM (t) UCL	0.243	95% KM (Percentile Bootstrap) UCL	0.248
95% KM (z) UCL	0.237	95% KM Bootstrap t UCL	0.662
90% KM Chebyshev UCL	0.305	95% KM Chebyshev UCL	0.373
97.5% KM Chebyshev UCL	0.468	99% KM Chebyshev UCL	0.653

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.26	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.315	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.232	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.986	k star (bias corrected MLE)	1.608
Theta hat (MLE)	0.0777	Theta star (bias corrected MLE)	0.0959
nu hat (MLE)	55.62	nu star (bias corrected)	45.03
Mean (detects)	0.154		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.06	Mean	0.153
Maximum	0.8	Median	0.1
SD	0.181	CV	1.187
k hat (MLE)	2.111	k star (bias corrected MLE)	1.733
Theta hat (MLE)	0.0723	Theta star (bias corrected MLE)	0.088
nu hat (MLE)	63.32	nu star (bias corrected)	51.99
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (51.99, α)	36.43	Adjusted Chi Square Value (51.99, β)	34.83
95% Gamma Approximate UCL (use when n>=50)	0.218	95% Gamma Adjusted UCL (use when n<50)	0.228

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.154	SD (KM)	0.181
Variance (KM)	0.0327	SE of Mean (KM)	0.0502
k hat (KM)	0.728	k star (KM)	0.627
nu hat (KM)	21.83	nu star (KM)	18.8
theta hat (KM)	0.212	theta star (KM)	0.246
80% gamma percentile (KM)	0.254	90% gamma percentile (KM)	0.397
95% gamma percentile (KM)	0.547	99% gamma percentile (KM)	0.906

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.80, α)	9.971	Adjusted Chi Square Value (18.80, β)	9.187
95% Gamma Approximate KM-UCL (use when n>=50)	0.291	95% Gamma Adjusted KM-UCL (use when n<50)	0.316

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.705	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.152	Mean in Log Scale	-2.141
SD in Original Scale	0.181	SD in Log Scale	0.585
95% t UCL (assumes normality of ROS data)	0.234	95% Percentile Bootstrap UCL	0.241
95% BCA Bootstrap UCL	0.295	95% Bootstrap t UCL	0.607
95% H-UCL (Log ROS)	0.195		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.141	KM Geo Mean	0.118
KM SD (logged)	0.585	95% Critical H Value (KM-Log)	2.163
KM Standard Error of Mean (logged)	0.162	95% H-UCL (KM -Log)	0.195
KM SD (logged)	0.585	95% Critical H Value (KM-Log)	2.163
KM Standard Error of Mean (logged)	0.162		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.203	Mean in Log Scale	-2.006
SD in Original Scale	0.262	SD in Log Scale	0.784
95% t UCL (Assumes normality)	0.323	95% H-Stat UCL	0.304

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.373

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	7
Number of Distinct Detects	5	Number of Distinct Non-Detects	4

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	0.09	Minimum Non-Detect	0.08
Maximum Detect	2.9	Maximum Non-Detect	4.46
Variance Detects	0.905	Percent Non-Detects	46.67%
Mean Detects	0.551	SD Detects	0.951
Median Detects	0.21	CV Detects	1.726
Skewness Detects	2.801	Kurtosis Detects	7.884
Mean of Logged Detects	-1.262	SD of Logged Detects	1.011

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.484	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.479	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.392	KM Standard Error of Mean	0.201
KM SD	0.7	95% KM (BCA) UCL	0.797
95% KM (t) UCL	0.745	95% KM (Percentile Bootstrap) UCL	0.752
95% KM (z) UCL	0.722	95% KM Bootstrap t UCL	2.412
90% KM Chebyshev UCL	0.993	95% KM Chebyshev UCL	1.266
97.5% KM Chebyshev UCL	1.644	99% KM Chebyshev UCL	2.387

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.523	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.74	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.433	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.303	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.88	k star (bias corrected MLE)	0.633
Theta hat (MLE)	0.626	Theta star (bias corrected MLE)	0.87
nu hat (MLE)	14.08	nu star (bias corrected)	10.13
Mean (detects)	0.551		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.375
Maximum	2.9	Median	0.2
SD	0.715	CV	1.908
k hat (MLE)	0.614	k star (bias corrected MLE)	0.536
Theta hat (MLE)	0.61	Theta star (bias corrected MLE)	0.699
nu hat (MLE)	18.43	nu star (bias corrected)	16.08
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (16.08, α)	8.018	Adjusted Chi Square Value (16.08, β)	7.326
95% Gamma Approximate UCL (use when n>=50)	0.751	95% Gamma Adjusted UCL (use when n<50)	0.822

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.392	SD (KM)	0.7
Variance (KM)	0.489	SE of Mean (KM)	0.201
k hat (KM)	0.313	k star (KM)	0.295
nu hat (KM)	9.405	nu star (KM)	8.857
theta hat (KM)	1.249	theta star (KM)	1.327
80% gamma percentile (KM)	0.598	90% gamma percentile (KM)	1.157
95% gamma percentile (KM)	1.801	99% gamma percentile (KM)	3.477

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.86, α)	3.241	Adjusted Chi Square Value (8.86, β)	2.836
95% Gamma Approximate KM-UCL (use when n>=50)	1.07	95% Gamma Adjusted KM-UCL (use when n<50)	1.223

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.743	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.352	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.381	Mean in Log Scale	-1.559
SD in Original Scale	0.703	SD in Log Scale	0.938
95% t UCL (assumes normality of ROS data)	0.7	95% Percentile Bootstrap UCL	0.733
95% BCA Bootstrap UCL	0.921	95% Bootstrap t UCL	2.138
95% H-UCL (Log ROS)	0.634		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.512	KM Geo Mean	0.22
KM SD (logged)	0.844	95% Critical H Value (KM-Log)	2.506
KM Standard Error of Mean (logged)	0.262	95% H-UCL (KM -Log)	0.554
KM SD (logged)	0.844	95% Critical H Value (KM-Log)	2.506
KM Standard Error of Mean (logged)	0.262		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.579	Mean in Log Scale	-1.158
SD in Original Scale	0.828	SD in Log Scale	1.072
95% t UCL (Assumes normality)	0.955	95% H-Stat UCL	1.267

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	1.266

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 4. ProUCL Output - Beaver Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Vanadium (mg/kg)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	21.5	Mean	21.5
Maximum	21.5	Median	21.5

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Vanadium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Zinc (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	3800	Mean	5035
Maximum	6270	Median	5035

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Zinc (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:13:24 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	8010	Mean	10327
Maximum	13700	Median	9270
SD	2989	Std. Error of Mean	1725
Coefficient of Variation	0.289	Skewness	1.392

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.906	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.305	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	15365	95% Adjusted-CLT UCL (Chen-1995)	14647
		95% Modified-t UCL (Johnson-1978)	15596

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	19.08	k star (bias corrected MLE)	N/A
Theta hat (MLE)	541.3	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	114.5	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.282	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.988	Mean of logged Data	9.216
Maximum of Logged Data	9.525	SD of logged Data	0.277

Assuming Lognormal Distribution

95% H-UCL	22476	90% Chebyshev (MVUE) UCL	15228
95% Chebyshev (MVUE) UCL	17453	97.5% Chebyshev (MVUE) UCL	20541
99% Chebyshev (MVUE) UCL	26606		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	13165	95% Jackknife UCL	15365
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	15503	95% Chebyshev(Mean, Sd) UCL	17848
97.5% Chebyshev(Mean, Sd) UCL	21102	99% Chebyshev(Mean, Sd) UCL	27495

Suggested UCL to Use

95% Student's-t UCL 15365

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	1
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	2.58	Minimum Non-Detect	2.14
Maximum Detect	4	Maximum Non-Detect	2.14
Variance Detects	1.008	Percent Non-Detects	33.33%
Mean Detects	3.29	SD Detects	1.004
Median Detects	3.29	CV Detects	0.305
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.167	SD of Logged Detects	0.31

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.907	KM Standard Error of Mean	0.648
KM SD	0.794	95% KM (BCA) UCL	N/A
95% KM (t) UCL	4.799	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.973	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.851	95% KM Chebyshev UCL	5.731
97.5% KM Chebyshev UCL	6.954	99% KM Chebyshev UCL	9.355

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	21.13	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.156	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	84.53	nu star (bias corrected)	N/A
Mean (detects)	3.29		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.907	SD (KM)	0.794
Variance (KM)	0.63	SE of Mean (KM)	0.648
k hat (KM)	13.41	k star (KM)	N/A
nu hat (KM)	80.47	nu star (KM)	N/A
theta hat (KM)	0.217	theta star (KM)	N/A
80% gamma percentile (KM)	N/A	90% gamma percentile (KM)	N/A
95% gamma percentile (KM)	N/A	99% gamma percentile (KM)	N/A

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.00136
Approximate Chi Square Value (N/A, α)	N/A	Adjusted Chi Square Value (N/A, β)	N/A
95% Gamma Approximate KM-UCL (use when n>=50)	N/A	95% Gamma Adjusted KM-UCL (use when n<50)	N/A

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.589	Mean in Log Scale	0.835
SD in Original Scale	1.407	SD in Log Scale	0.615
95% t UCL (assumes normality of ROS data)	4.96	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	90.92		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.032	KM Geo Mean	2.806
KM SD (logged)	0.262	95% Critical H Value (KM-Log)	3.769
KM Standard Error of Mean (logged)	0.214	95% H-UCL (KM -Log)	5.84
KM SD (logged)	0.262	95% Critical H Value (KM-Log)	3.769
KM Standard Error of Mean (logged)	0.214		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.55	Mean in Log Scale	0.801
SD in Original Scale	1.465	SD in Log Scale	0.672
95% t UCL (Assumes normality)	5.02	95% H-Stat UCL	177.5

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	4.799	KM H-UCL	5.84
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!
Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	108	Mean	118
Maximum	130	Median	116
SD	11.14	Std. Error of Mean	6.429
Coefficient of Variation	0.0944	Skewness	0.782

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	136.8	95% Adjusted-CLT UCL (Chen-1995)	131.7
		95% Modified-t UCL (Johnson-1978)	137.3

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	170.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.691	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	1024	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.983	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.227	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.682	Mean of logged Data	4.768
Maximum of Logged Data	4.868	SD of logged Data	0.0935

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	137.1
95% Chebyshev (MVUE) UCL	145.7	97.5% Chebyshev (MVUE) UCL	157.7
99% Chebyshev (MVUE) UCL	181.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	128.6	95% Jackknife UCL	136.8
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	137.3	95% Chebyshev(Mean, Sd) UCL	146
97.5% Chebyshev(Mean, Sd) UCL	158.1	99% Chebyshev(Mean, Sd) UCL	182

Suggested UCL to Use

95% Student's-t UCL 136.8

Recommended UCL exceeds the maximum observation

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.3	Mean	3.693
Maximum	25.2	Median	0.955
SD	7.658	Std. Error of Mean	2.422
Coefficient of Variation	2.074	Skewness	3.018

Normal GOF Test

Shapiro Wilk Test Statistic	0.488	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.4	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8.132	95% Adjusted-CLT UCL (Chen-1995)	10.15
		95% Modified-t UCL (Johnson-1978)	8.517

Gamma GOF Test

A-D Test Statistic	1.155	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.77	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.321	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.279	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.586	k star (bias corrected MLE)	0.477
Theta hat (MLE)	6.302	Theta star (bias corrected MLE)	7.745
nu hat (MLE)	11.72	nu star (bias corrected)	9.537
MLE Mean (bias corrected)	3.693	MLE Sd (bias corrected)	5.348
		Approximate Chi Square Value (0.05)	3.654
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	3.049

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	9.637	95% Adjusted Gamma UCL (use when n<50)	11.55

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.207	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal Statistics

Minimum of Logged Data	-1.204	Mean of logged Data	0.248
Maximum of Logged Data	3.227	SD of logged Data	1.317

Assuming Lognormal Distribution

95% H-UCL	16.09	90% Chebyshev (MVUE) UCL	6.19
95% Chebyshev (MVUE) UCL	7.785	97.5% Chebyshev (MVUE) UCL	10
99% Chebyshev (MVUE) UCL	14.35		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.676	95% Jackknife UCL	8.132
95% Standard Bootstrap UCL	7.425	95% Bootstrap-t UCL	44.14
95% Hall's Bootstrap UCL	26.6	95% Percentile Bootstrap UCL	8.197
95% BCA Bootstrap UCL	10.83		
90% Chebyshev(Mean, Sd) UCL	10.96	95% Chebyshev(Mean, Sd) UCL	14.25
97.5% Chebyshev(Mean, Sd) UCL	18.82	99% Chebyshev(Mean, Sd) UCL	27.79

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 14.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	21.5	Mean	24.5
Maximum	28.4	Median	23.6
SD	3.537	Std. Error of Mean	2.042
Coefficient of Variation	0.144	Skewness	1.071

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	30.46	95% Adjusted-CLT UCL (Chen-1995)	29.21
		95% Modified-t UCL (Johnson-1978)	30.67

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	73.95	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.331	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	443.7	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.068	Mean of logged Data	3.192
Maximum of Logged Data	3.346	SD of logged Data	0.142

Assuming Lognormal Distribution

95% H-UCL	33.01	90% Chebyshev (MVUE) UCL	30.49
95% Chebyshev (MVUE) UCL	33.21	97.5% Chebyshev (MVUE) UCL	36.98
99% Chebyshev (MVUE) UCL	44.39		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	27.86	95% Jackknife UCL	30.46
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	30.63	95% Chebyshev(Mean, Sd) UCL	33.4
97.5% Chebyshev(Mean, Sd) UCL	37.25	99% Chebyshev(Mean, Sd) UCL	44.82

Suggested UCL to Use

95% Student's-t UCL 30.46

Recommended UCL exceeds the maximum observation

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
Number of Detects	1	Number of Non-Detects	2
Number of Distinct Detects	1	Number of Distinct Non-Detects	2

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Cobalt (mg/kg) was not processed!

Copper (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	7.12	Mean	8.66
Maximum	10.7	Median	8.16
SD	1.842	Std. Error of Mean	1.063
Coefficient of Variation	0.213	Skewness	1.132

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.274	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	11.76	95% Adjusted-CLT UCL (Chen-1995)	11.15
		95% Modified-t UCL (Johnson-1978)	11.88

Gamma GOF Test

Not Enough Data to Perform GOF Test

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	34.45	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.251	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	206.7	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.252	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.963	Mean of logged Data	2.144
Maximum of Logged Data	2.37	SD of logged Data	0.207

Assuming Lognormal Distribution

95% H-UCL	14.24	90% Chebyshev (MVUE) UCL	11.75
95% Chebyshev (MVUE) UCL	13.15	97.5% Chebyshev (MVUE) UCL	15.1
99% Chebyshev (MVUE) UCL	18.91		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	10.41	95% Jackknife UCL	11.76
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	11.85	95% Chebyshev(Mean, Sd) UCL	13.29
97.5% Chebyshev(Mean, Sd) UCL	15.3	99% Chebyshev(Mean, Sd) UCL	19.24

Suggested UCL to Use

95% Student's-t UCL 11.76

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Iron (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	10900	Mean	13533
Maximum	16700	Median	13000
SD	2937	Std. Error of Mean	1695
Coefficient of Variation	0.217	Skewness	0.79

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	18484	95% Adjusted-CLT UCL (Chen-1995)	17149
		95% Modified-t UCL (Johnson-1978)	18613

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	32.53	k star (bias corrected MLE)	N/A
Theta hat (MLE)	416	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	195.2	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.99	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.297	Mean of logged Data	9.497
Maximum of Logged Data	9.723	SD of logged Data	0.214

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	22816	90% Chebyshev (MVUE) UCL	18527
95% Chebyshev (MVUE) UCL	20790	97.5% Chebyshev (MVUE) UCL	23931
99% Chebyshev (MVUE) UCL	30101		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	16322	95% Jackknife UCL	18484
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	18620	95% Chebyshev(Mean, Sd) UCL	20923
97.5% Chebyshev(Mean, Sd) UCL	24121	99% Chebyshev(Mean, Sd) UCL	30403

Suggested UCL to Use

95% Student's-t UCL 18484

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	6	Mean	167.7
Maximum	1450	Median	23.6
SD	450.7	Std. Error of Mean	142.5
Coefficient of Variation	2.688	Skewness	3.157

Normal GOF Test

Shapiro Wilk Test Statistic	0.392	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.508	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	429	95% Adjusted-CLT UCL (Chen-1995)	554.2
		95% Modified-t UCL (Johnson-1978)	452.7

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	2.059	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.795	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.455	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.284	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.402	k star (bias corrected MLE)	0.348
Theta hat (MLE)	416.7	Theta star (bias corrected MLE)	481.4
nu hat (MLE)	8.048	nu star (bias corrected)	6.967
MLE Mean (bias corrected)	167.7	MLE Sd (bias corrected)	284.1
		Approximate Chi Square Value (0.05)	2.152
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	1.719

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	542.7	95% Adjusted Gamma UCL (use when n<50)	679.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.761	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.316	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.262	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.792	Mean of logged Data	3.488
Maximum of Logged Data	7.279	SD of logged Data	1.463

Assuming Lognormal Distribution

95% H-UCL	711.1	90% Chebyshev (MVUE) UCL	196.9
95% Chebyshev (MVUE) UCL	250	97.5% Chebyshev (MVUE) UCL	323.6
99% Chebyshev (MVUE) UCL	468.2		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	402.1	95% Jackknife UCL	429
95% Standard Bootstrap UCL	392.5	95% Bootstrap-t UCL	6525
95% Hall's Bootstrap UCL	3071	95% Percentile Bootstrap UCL	452
95% BCA Bootstrap UCL	594.2		
90% Chebyshev(Mean, Sd) UCL	595.3	95% Chebyshev(Mean, Sd) UCL	789
97.5% Chebyshev(Mean, Sd) UCL	1058	99% Chebyshev(Mean, Sd) UCL	1586

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	789

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Manganese (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	560	Mean	1260
Maximum	2570	Median	649
SD	1136	Std. Error of Mean	655.7
Coefficient of Variation	0.902	Skewness	1.72

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.783	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.371	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3174	95% Adjusted-CLT UCL (Chen-1995)	3034
		95% Modified-t UCL (Johnson-1978)	3283

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	2.123	k star (bias corrected MLE)	N/A
Theta hat (MLE)	593.3	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	12.74	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.822	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.354	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.328	Mean of logged Data	6.885
Maximum of Logged Data	7.852	SD of logged Data	0.84

Assuming Lognormal Distribution

95% H-UCL	937039	90% Chebyshev (MVUE) UCL	2859
95% Chebyshev (MVUE) UCL	3601	97.5% Chebyshev (MVUE) UCL	4631
99% Chebyshev (MVUE) UCL	6654		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2338	95% Jackknife UCL	3174
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3227	95% Chebyshev(Mean, Sd) UCL	4118
97.5% Chebyshev(Mean, Sd) UCL	5354	99% Chebyshev(Mean, Sd) UCL	7784

Suggested UCL to Use

95% Student's-t UCL 3174

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	13.2	Mean	13.9
Maximum	15	Median	13.5
SD	0.964	Std. Error of Mean	0.557
Coefficient of Variation	0.0694	Skewness	1.545

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.871	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.328	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	15.53	95% Adjusted-CLT UCL (Chen-1995)	15.35
		95% Modified-t UCL (Johnson-1978)	15.61

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	318.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0436	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	1912	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.877	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.324	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.58	Mean of logged Data	2.63
Maximum of Logged Data	2.708	SD of logged Data	0.0682

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	15.54
95% Chebyshev (MVUE) UCL	16.29	97.5% Chebyshev (MVUE) UCL	17.32
99% Chebyshev (MVUE) UCL	19.35		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	14.82	95% Jackknife UCL	15.53
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	15.57	95% Chebyshev(Mean, Sd) UCL	16.33
97.5% Chebyshev(Mean, Sd) UCL	17.38	99% Chebyshev(Mean, Sd) UCL	19.44

Suggested UCL to Use

95% Student's-t UCL 15.53

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Vanadium (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	20.5	Mean	22.6
Maximum	23.8	Median	23.5
SD	1.825	Std. Error of Mean	1.054
Coefficient of Variation	0.0807	Skewness	-1.68

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.818	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.356	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	25.68	95% Adjusted-CLT UCL (Chen-1995)	23.24
		95% Modified-t UCL (Johnson-1978)	25.51

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	222.8	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.101	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	1337	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.813	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.358	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.02	Mean of logged Data	3.116
Maximum of Logged Data	3.17	SD of logged Data	0.0828

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	25.84
95% Chebyshev (MVUE) UCL	27.3	97.5% Chebyshev (MVUE) UCL	29.34
99% Chebyshev (MVUE) UCL	33.34		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	24.33	95% Jackknife UCL	25.68
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	25.76	95% Chebyshev(Mean, Sd) UCL	27.19
97.5% Chebyshev(Mean, Sd) UCL	29.18	99% Chebyshev(Mean, Sd) UCL	33.08

Suggested UCL to Use

95% Student's-t UCL 25.68

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Zinc (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	31.2	Mean	550.1
Maximum	3410	Median	198
SD	1023	Std. Error of Mean	323.4
Coefficient of Variation	1.859	Skewness	2.976

Normal GOF Test

Shapiro Wilk Test Statistic	0.503	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.412	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1143	95% Adjusted-CLT UCL (Chen-1995)	1407
		95% Modified-t UCL (Johnson-1978)	1194

Appendix D, Table 5. ProUCL Output - Lost Creek Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	1.196	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.361	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.277	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.713	k star (bias corrected MLE)	0.566
Theta hat (MLE)	771.5	Theta star (bias corrected MLE)	972.2
nu hat (MLE)	14.26	nu star (bias corrected)	11.32
MLE Mean (bias corrected)	550.1	MLE Sd (bias corrected)	731.3
		Approximate Chi Square Value (0.05)	4.78
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	4.068

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1302	95% Adjusted Gamma UCL (use when n<50)	1530

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.271	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.262	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.44	Mean of logged Data	5.465
Maximum of Logged Data	8.134	SD of logged Data	1.221

Assuming Lognormal Distribution

95% H-UCL	2135	90% Chebyshev (MVUE) UCL	991.4
95% Chebyshev (MVUE) UCL	1239	97.5% Chebyshev (MVUE) UCL	1582
99% Chebyshev (MVUE) UCL	2255		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1082	95% Jackknife UCL	1143
95% Standard Bootstrap UCL	1044	95% Bootstrap-t UCL	6704
95% Hall's Bootstrap UCL	5179	95% Percentile Bootstrap UCL	1163
95% BCA Bootstrap UCL	1484		
90% Chebyshev(Mean, Sd) UCL	1520	95% Chebyshev(Mean, Sd) UCL	1960
97.5% Chebyshev(Mean, Sd) UCL	2570	99% Chebyshev(Mean, Sd) UCL	3768

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 1960

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:17:33 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	40
		Number of Missing Observations	0
Minimum	3.6	Mean	5949
Maximum	22000	Median	7.95
SD	7609	Std. Error of Mean	1122
Coefficient of Variation	1.279	Skewness	0.995

Normal GOF Test

Shapiro Wilk Test Statistic	0.756	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.304	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7833	95% Adjusted-CLT UCL (Chen-1995)	7970
		95% Modified-t UCL (Johnson-1978)	7860

Gamma GOF Test

A-D Test Statistic	5.251	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.903	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.332	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.145	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.216	k star (bias corrected MLE)	0.217
Theta hat (MLE)	27486	Theta star (bias corrected MLE)	27438
nu hat (MLE)	19.91	nu star (bias corrected)	19.95
MLE Mean (bias corrected)	5949	MLE Sd (bias corrected)	12776
		Approximate Chi Square Value (0.05)	10.81
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	10.59

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	10975	95% Adjusted Gamma UCL (use when n<50)	11201

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.704	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.32	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.281	Mean of logged Data	5.333
Maximum of Logged Data	9.999	SD of logged Data	3.855

Assuming Lognormal Distribution

95% H-UCL	13101720	90% Chebyshev (MVUE) UCL	459220
95% Chebyshev (MVUE) UCL	608494	97.5% Chebyshev (MVUE) UCL	815681
99% Chebyshev (MVUE) UCL	1222658		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	7794	95% Jackknife UCL	7833
95% Standard Bootstrap UCL	7724	95% Bootstrap-t UCL	8032
95% Hall's Bootstrap UCL	7976	95% Percentile Bootstrap UCL	7892
95% BCA Bootstrap UCL	8002		
90% Chebyshev(Mean, Sd) UCL	9314	95% Chebyshev(Mean, Sd) UCL	10839
97.5% Chebyshev(Mean, Sd) UCL	12955	99% Chebyshev(Mean, Sd) UCL	17111

Suggested UCL to Use

95% Hall's Bootstrap UCL 7976

In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	39	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	3	Mean	11.7
Maximum	30	Median	10
SD	6.784	Std. Error of Mean	1.086
Coefficient of Variation	0.58	Skewness	1.008

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.939	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	13.53	95% Adjusted-CLT UCL (Chen-1995)	13.67
		95% Modified-t UCL (Johnson-1978)	13.56

Gamma GOF Test

A-D Test Statistic	0.756	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.154	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.142	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.091	k star (bias corrected MLE)	2.87
Theta hat (MLE)	3.785	Theta star (bias corrected MLE)	4.076
nu hat (MLE)	241.1	nu star (bias corrected)	223.9
MLE Mean (bias corrected)	11.7	MLE Sd (bias corrected)	6.906
		Approximate Chi Square Value (0.05)	190.2
Adjusted Level of Significance	0.0437	Adjusted Chi Square Value	189

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	13.77	95% Adjusted Gamma UCL (use when n<50)	13.86

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.939	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.193	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.099	Mean of logged Data	2.289
Maximum of Logged Data	3.401	SD of logged Data	0.613

Assuming Lognormal Distribution

95% H-UCL	14.53	90% Chebyshev (MVUE) UCL	15.56
95% Chebyshev (MVUE) UCL	17.25	97.5% Chebyshev (MVUE) UCL	19.59
99% Chebyshev (MVUE) UCL	24.2		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	13.49	95% Jackknife UCL	13.53
95% Standard Bootstrap UCL	13.44	95% Bootstrap-t UCL	13.81
95% Hall's Bootstrap UCL	13.89	95% Percentile Bootstrap UCL	13.52
95% BCA Bootstrap UCL	13.73		
90% Chebyshev(Mean, Sd) UCL	14.96	95% Chebyshev(Mean, Sd) UCL	16.43
97.5% Chebyshev(Mean, Sd) UCL	18.48	99% Chebyshev(Mean, Sd) UCL	22.51

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 16.43

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	54	Mean	303.9
Maximum	550	Median	375
SD	182.5	Std. Error of Mean	26.91
Coefficient of Variation	0.6	Skewness	-0.124

Normal GOF Test

Shapiro Wilk Test Statistic	0.815	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	349.1	95% Adjusted-CLT UCL (Chen-1995)	347.7
		95% Modified-t UCL (Johnson-1978)	349

Gamma GOF Test

A-D Test Statistic	3.033	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.253	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.132	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.1	k star (bias corrected MLE)	1.978
Theta hat (MLE)	144.7	Theta star (bias corrected MLE)	153.7
nu hat (MLE)	193.2	nu star (bias corrected)	182
MLE Mean (bias corrected)	303.9	MLE Sd (bias corrected)	216.1
		Approximate Chi Square Value (0.05)	151.8
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	150.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	364.4	95% Adjusted Gamma UCL (use when n<50)	366.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.825	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.258	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.989	Mean of logged Data	5.46
Maximum of Logged Data	6.31	SD of logged Data	0.795

Assuming Lognormal Distribution

95% H-UCL	414.8	90% Chebyshev (MVUE) UCL	445.2
95% Chebyshev (MVUE) UCL	502.1	97.5% Chebyshev (MVUE) UCL	581
99% Chebyshev (MVUE) UCL	736		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	348.2	95% Jackknife UCL	349.1
95% Standard Bootstrap UCL	347.9	95% Bootstrap-t UCL	346.2
95% Hall's Bootstrap UCL	347.1	95% Percentile Bootstrap UCL	348
95% BCA Bootstrap UCL	344.9		
90% Chebyshev(Mean, Sd) UCL	384.6	95% Chebyshev(Mean, Sd) UCL	421.2
97.5% Chebyshev(Mean, Sd) UCL	472	99% Chebyshev(Mean, Sd) UCL	571.6

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 421.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	21
Number of Detects	45	Number of Non-Detects	1
Number of Distinct Detects	20	Number of Distinct Non-Detects	1

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	0.5	Minimum Non-Detect	0.692
Maximum Detect	4	Maximum Non-Detect	0.692
Variance Detects	0.605	Percent Non-Detects	2.174%
Mean Detects	1.563	SD Detects	0.778
Median Detects	1.5	CV Detects	0.498
Skewness Detects	0.772	Kurtosis Detects	0.858
Mean of Logged Detects	0.317	SD of Logged Detects	0.533

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.541	KM Standard Error of Mean	0.115
KM SD	0.774	95% KM (BCA) UCL	1.733
95% KM (t) UCL	1.735	95% KM (Percentile Bootstrap) UCL	1.743
95% KM (z) UCL	1.731	95% KM Bootstrap t UCL	1.759
90% KM Chebyshev UCL	1.888	95% KM Chebyshev UCL	2.045
97.5% KM Chebyshev UCL	2.263	99% KM Chebyshev UCL	2.69

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.52	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.218	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.132	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.018	k star (bias corrected MLE)	3.765
Theta hat (MLE)	0.389	Theta star (bias corrected MLE)	0.415
nu hat (MLE)	361.6	nu star (bias corrected)	338.9
Mean (detects)	1.563		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.5	Mean	1.542
Maximum	4	Median	1.45
SD	0.783	CV	0.508
k hat (MLE)	3.877	k star (bias corrected MLE)	3.639
Theta hat (MLE)	0.398	Theta star (bias corrected MLE)	0.424
nu hat (MLE)	356.7	nu star (bias corrected)	334.8
Adjusted Level of Significance (β)	0.0448		
Approximate Chi Square Value (334.79, α)	293.4	Adjusted Chi Square Value (334.79, β)	292.1
95% Gamma Approximate UCL (use when n>=50)	1.759	95% Gamma Adjusted UCL (use when n<50)	1.767

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.541	SD (KM)	0.774
Variance (KM)	0.6	SE of Mean (KM)	0.115
k hat (KM)	3.962	k star (KM)	3.718
nu hat (KM)	364.5	nu star (KM)	342
theta hat (KM)	0.389	theta star (KM)	0.415
80% gamma percentile (KM)	2.143	90% gamma percentile (KM)	2.613
95% gamma percentile (KM)	3.047	99% gamma percentile (KM)	3.977

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (342.04, α)	300.2	Adjusted Chi Square Value (342.04, β)	298.9
95% Gamma Approximate KM-UCL (use when n>=50)	1.756	95% Gamma Adjusted KM-UCL (use when n<50)	1.764

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.227	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.131	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.542	Mean in Log Scale	0.3
SD in Original Scale	0.782	SD in Log Scale	0.54
95% t UCL (assumes normality of ROS data)	1.736	95% Percentile Bootstrap UCL	1.729
95% BCA Bootstrap UCL	1.754	95% Bootstrap t UCL	1.748
95% H-UCL (Log ROS)	1.821		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.298	KM Geo Mean	1.347
KM SD (logged)	0.537	95% Critical H Value (KM-Log)	1.91
KM Standard Error of Mean (logged)	0.0801	95% H-UCL (KM -Log)	1.813
KM SD (logged)	0.537	95% Critical H Value (KM-Log)	1.91
KM Standard Error of Mean (logged)	0.0801		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.537	Mean in Log Scale	0.287
SD in Original Scale	0.79	SD in Log Scale	0.564
95% t UCL (Assumes normality)	1.732	95% H-Stat UCL	1.838

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	2.045

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Boron (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	10
Number of Detects	10	Number of Non-Detects	9
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	2.8	Minimum Non-Detect	2.5
Maximum Detect	64	Maximum Non-Detect	2.5
Variance Detects	316.4	Percent Non-Detects	47.37%
Mean Detects	14.05	SD Detects	17.79
Median Detects	8.05	CV Detects	1.266
Skewness Detects	3.007	Kurtosis Detects	9.29
Mean of Logged Detects	2.275	SD of Logged Detects	0.784

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.518	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.401	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	8.579	KM Standard Error of Mean	3.272
KM SD	13.53	95% KM (BCA) UCL	15.19
95% KM (t) UCL	14.25	95% KM (Percentile Bootstrap) UCL	14.82
95% KM (z) UCL	13.96	95% KM Bootstrap t UCL	25.79
90% KM Chebyshev UCL	18.4	95% KM Chebyshev UCL	22.84
97.5% KM Chebyshev UCL	29.01	99% KM Chebyshev UCL	41.14

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.354	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.739	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.304	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.271	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.506	k star (bias corrected MLE)	1.121
Theta hat (MLE)	9.328	Theta star (bias corrected MLE)	12.53
nu hat (MLE)	30.12	nu star (bias corrected)	22.42
Mean (detects)	14.05		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	0.01	Mean	7.399
Maximum	64	Median	2.8
SD	14.49	CV	1.959
k hat (MLE)	0.24	k star (bias corrected MLE)	0.237
Theta hat (MLE)	30.89	Theta star (bias corrected MLE)	31.24
nu hat (MLE)	9.104	nu star (bias corrected)	9
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (9.00, α)	3.327	Adjusted Chi Square Value (9.00, β)	3.031
95% Gamma Approximate UCL (use when n>=50)	20.02	95% Gamma Adjusted UCL (use when n<50)	21.97

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	8.579	SD (KM)	13.53
Variance (KM)	183.1	SE of Mean (KM)	3.272
k hat (KM)	0.402	k star (KM)	0.374
nu hat (KM)	15.27	nu star (KM)	14.2
theta hat (KM)	21.34	theta star (KM)	22.97
80% gamma percentile (KM)	13.72	90% gamma percentile (KM)	24.52
95% gamma percentile (KM)	36.49	99% gamma percentile (KM)	66.83

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (14.20, α)	6.705	Adjusted Chi Square Value (14.20, β)	6.259
95% Gamma Approximate KM-UCL (use when n>=50)	18.16	95% Gamma Adjusted KM-UCL (use when n<50)	19.46

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.821	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	8.112	Mean in Log Scale	1.314
SD in Original Scale	14.14	SD in Log Scale	1.259
95% t UCL (assumes normality of ROS data)	13.74	95% Percentile Bootstrap UCL	14.25
95% BCA Bootstrap UCL	17.25	95% Bootstrap t UCL	24.17
95% H-UCL (Log ROS)	19.99		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.632	KM Geo Mean	5.112
KM SD (logged)	0.867	95% Critical H Value (KM-Log)	2.428
KM Standard Error of Mean (logged)	0.21	95% H-UCL (KM -Log)	12.22
KM SD (logged)	0.867	95% Critical H Value (KM-Log)	2.428
KM Standard Error of Mean (logged)	0.21		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	7.987	Mean in Log Scale	1.303
SD in Original Scale	14.19	SD in Log Scale	1.19
95% t UCL (Assumes normality)	13.63	95% H-Stat UCL	16.8

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use
KM H-UCL 12.22

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	44
		Number of Missing Observations	0
Minimum	0.49	Mean	15.26
Maximum	180	Median	8
SD	29.05	Std. Error of Mean	3.69
Coefficient of Variation	1.904	Skewness	4.315

Normal GOF Test

Shapiro Wilk Test Statistic	0.475	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.322	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	21.43	95% Adjusted-CLT UCL (Chen-1995)	23.49
		95% Modified-t UCL (Johnson-1978)	21.76

Gamma GOF Test

A-D Test Statistic	2.091	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.794	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.152	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.118	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.728	k star (bias corrected MLE)	0.703
Theta hat (MLE)	20.97	Theta star (bias corrected MLE)	21.7
nu hat (MLE)	90.27	nu star (bias corrected)	87.23
MLE Mean (bias corrected)	15.26	MLE Sd (bias corrected)	18.2
		Approximate Chi Square Value (0.05)	66.7
Adjusted Level of Significance	0.0461	Adjusted Chi Square Value	66.27

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	19.96	95% Adjusted Gamma UCL (use when n<50)	20.09

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.968	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.235	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0937	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.112	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.713	Mean of logged Data	1.9
Maximum of Logged Data	5.193	SD of logged Data	1.252

Assuming Lognormal Distribution

95% H-UCL	21	90% Chebyshev (MVUE) UCL	22.97
95% Chebyshev (MVUE) UCL	26.89	97.5% Chebyshev (MVUE) UCL	32.33
99% Chebyshev (MVUE) UCL	43.01		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	21.33	95% Jackknife UCL	21.43
95% Standard Bootstrap UCL	21.17	95% Bootstrap-t UCL	28.27
95% Hall's Bootstrap UCL	43.69	95% Percentile Bootstrap UCL	21.6
95% BCA Bootstrap UCL	23.63		
90% Chebyshev(Mean, Sd) UCL	26.33	95% Chebyshev(Mean, Sd) UCL	31.35
97.5% Chebyshev(Mean, Sd) UCL	38.31	99% Chebyshev(Mean, Sd) UCL	51.98

Suggested UCL to Use

95% H-UCL 21

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Chromium (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	35
		Number of Missing Observations	0
Minimum	11	Mean	54.86
Maximum	160	Median	50
SD	30.18	Std. Error of Mean	4.449
Coefficient of Variation	0.55	Skewness	0.935

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.129	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	62.33	95% Adjusted-CLT UCL (Chen-1995)	62.84
		95% Modified-t UCL (Johnson-1978)	62.44

Gamma GOF Test

A-D Test Statistic	0.517	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.12	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.131	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.165	k star (bias corrected MLE)	2.973
Theta hat (MLE)	17.33	Theta star (bias corrected MLE)	18.45
nu hat (MLE)	291.2	nu star (bias corrected)	273.5
MLE Mean (bias corrected)	54.86	MLE Sd (bias corrected)	31.82
		Approximate Chi Square Value (0.05)	236.2
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	235.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	63.53	95% Adjusted Gamma UCL (use when n<50)	63.83

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.156	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.398	Mean of logged Data	3.839
Maximum of Logged Data	5.075	SD of logged Data	0.618

Assuming Lognormal Distribution

95% H-UCL	67.46	90% Chebyshev (MVUE) UCL	72.42
95% Chebyshev (MVUE) UCL	79.87	97.5% Chebyshev (MVUE) UCL	90.21
99% Chebyshev (MVUE) UCL	110.5		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	62.18	95% Jackknife UCL	62.33
95% Standard Bootstrap UCL	62.2	95% Bootstrap-t UCL	63.13
95% Hall's Bootstrap UCL	63.74	95% Percentile Bootstrap UCL	62.57
95% BCA Bootstrap UCL	62.63		
90% Chebyshev(Mean, Sd) UCL	68.21	95% Chebyshev(Mean, Sd) UCL	74.26
97.5% Chebyshev(Mean, Sd) UCL	82.65	99% Chebyshev(Mean, Sd) UCL	99.13

Suggested UCL to Use

95% Student's-t UCL 62.33

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	7.6	Mean	19.27
Maximum	49	Median	17.5
SD	9.108	Std. Error of Mean	1.343
Coefficient of Variation	0.473	Skewness	1.354

Normal GOF Test

Shapiro Wilk Test Statistic	0.887	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.124	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	21.52	95% Adjusted-CLT UCL (Chen-1995)	21.76
		95% Modified-t UCL (Johnson-1978)	21.57

Gamma GOF Test

A-D Test Statistic	0.422	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0699	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.131	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	5.226	k star (bias corrected MLE)	4.9
Theta hat (MLE)	3.687	Theta star (bias corrected MLE)	3.932
nu hat (MLE)	480.8	nu star (bias corrected)	450.8
MLE Mean (bias corrected)	19.27	MLE Sd (bias corrected)	8.704
		Approximate Chi Square Value (0.05)	402.6
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	401.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	21.58	95% Adjusted Gamma UCL (use when n<50)	21.65

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0846	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.129	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.028	Mean of logged Data	2.86
Maximum of Logged Data	3.892	SD of logged Data	0.447

Assuming Lognormal Distribution

95% H-UCL	21.82	90% Chebyshev (MVUE) UCL	23.2
95% Chebyshev (MVUE) UCL	24.99	97.5% Chebyshev (MVUE) UCL	27.48
99% Chebyshev (MVUE) UCL	32.36		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	21.48	95% Jackknife UCL	21.52
95% Standard Bootstrap UCL	21.49	95% Bootstrap-t UCL	21.9
95% Hall's Bootstrap UCL	22.11	95% Percentile Bootstrap UCL	21.58
95% BCA Bootstrap UCL	21.71		
90% Chebyshev(Mean, Sd) UCL	23.3	95% Chebyshev(Mean, Sd) UCL	25.12
97.5% Chebyshev(Mean, Sd) UCL	27.65	99% Chebyshev(Mean, Sd) UCL	32.63

Suggested UCL to Use

95% Student's-t UCL 21.52

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Copper (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	27
		Number of Missing Observations	0
Minimum	6.43	Mean	21.59
Maximum	75	Median	19.35
SD	11.64	Std. Error of Mean	1.716
Coefficient of Variation	0.539	Skewness	2.667

Normal GOF Test

Shapiro Wilk Test Statistic	0.769	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	24.47	95% Adjusted-CLT UCL (Chen-1995)	25.13
		95% Modified-t UCL (Johnson-1978)	24.58

Gamma GOF Test

A-D Test Statistic	0.945	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.105	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.131	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.755	k star (bias corrected MLE)	4.459
Theta hat (MLE)	4.54	Theta star (bias corrected MLE)	4.841
nu hat (MLE)	437.5	nu star (bias corrected)	410.3
MLE Mean (bias corrected)	21.59	MLE Sd (bias corrected)	10.22
		Approximate Chi Square Value (0.05)	364.3
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	362.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	24.31	95% Adjusted Gamma UCL (use when n<50)	24.41

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.133	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.861	Mean of logged Data	2.963
Maximum of Logged Data	4.317	SD of logged Data	0.464

Assuming Lognormal Distribution

95% H-UCL	24.53	90% Chebyshev (MVUE) UCL	26.12
95% Chebyshev (MVUE) UCL	28.2	97.5% Chebyshev (MVUE) UCL	31.1
99% Chebyshev (MVUE) UCL	36.79		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	24.41	95% Jackknife UCL	24.47
95% Standard Bootstrap UCL	24.37	95% Bootstrap-t UCL	25.92
95% Hall's Bootstrap UCL	39.35	95% Percentile Bootstrap UCL	24.63
95% BCA Bootstrap UCL	25.24		
90% Chebyshev(Mean, Sd) UCL	26.74	95% Chebyshev(Mean, Sd) UCL	29.07
97.5% Chebyshev(Mean, Sd) UCL	32.31	99% Chebyshev(Mean, Sd) UCL	38.66

Suggested UCL to Use

95% Adjusted Gamma UCL 24.41

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	38
		Number of Missing Observations	0
Minimum	1.8	Mean	14554
Maximum	61000	Median	7.35
SD	18972	Std. Error of Mean	2797
Coefficient of Variation	1.304	Skewness	1.047

Normal GOF Test

Shapiro Wilk Test Statistic	0.755	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.3	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	19252	95% Adjusted-CLT UCL (Chen-1995)	19617
		95% Modified-t UCL (Johnson-1978)	19324

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	5.349	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.928	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.318	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.146	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.183	k star (bias corrected MLE)	0.186
Theta hat (MLE)	79489	Theta star (bias corrected MLE)	78397
nu hat (MLE)	16.84	nu star (bias corrected)	17.08
MLE Mean (bias corrected)	14554	MLE Sd (bias corrected)	33779
		Approximate Chi Square Value (0.05)	8.729
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	8.535

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	28477	95% Adjusted Gamma UCL (use when n<50)	29124

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.709	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.294	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.588	Mean of logged Data	5.511
Maximum of Logged Data	11.02	SD of logged Data	4.539

Assuming Lognormal Distribution

95% H-UCL	1.066E+9	90% Chebyshev (MVUE) UCL	5162348
95% Chebyshev (MVUE) UCL	6881409	97.5% Chebyshev (MVUE) UCL	9267398
99% Chebyshev (MVUE) UCL	13954213		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	19155	95% Jackknife UCL	19252
95% Standard Bootstrap UCL	19146	95% Bootstrap-t UCL	19706
95% Hall's Bootstrap UCL	19332	95% Percentile Bootstrap UCL	19515
95% BCA Bootstrap UCL	19467		
90% Chebyshev(Mean, Sd) UCL	22946	95% Chebyshev(Mean, Sd) UCL	26747
97.5% Chebyshev(Mean, Sd) UCL	32023	99% Chebyshev(Mean, Sd) UCL	42386

Suggested UCL to Use

95% Hall's Bootstrap UCL 19332

In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lead (mg/kg)

General Statistics

Total Number of Observations	67	Number of Distinct Observations	55
		Number of Missing Observations	0
Minimum	7.7	Mean	146.1
Maximum	810	Median	100
SD	158.1	Std. Error of Mean	19.32
Coefficient of Variation	1.082	Skewness	2.272

Normal GOF Test

Shapiro Wilk Test Statistic	0.742	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	8.882E-16	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.202	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.108	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	178.3	95% Adjusted-CLT UCL (Chen-1995)	183.6
		95% Modified-t UCL (Johnson-1978)	179.2

Gamma GOF Test

A-D Test Statistic	0.768	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.776	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.102	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.112	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.169	k star (bias corrected MLE)	1.127
Theta hat (MLE)	124.9	Theta star (bias corrected MLE)	129.6
nu hat (MLE)	156.7	nu star (bias corrected)	151
MLE Mean (bias corrected)	146.1	MLE Sd (bias corrected)	137.6
		Approximate Chi Square Value (0.05)	123.6
Adjusted Level of Significance	0.0464	Adjusted Chi Square Value	123.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	178.5	95% Adjusted Gamma UCL (use when n<50)	179.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.446	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0861	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.108	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.041	Mean of logged Data	4.499
Maximum of Logged Data	6.697	SD of logged Data	1.03

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	203.7	90% Chebyshev (MVUE) UCL	219.5
95% Chebyshev (MVUE) UCL	250.5	97.5% Chebyshev (MVUE) UCL	293.4
99% Chebyshev (MVUE) UCL	377.9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	177.9	95% Jackknife UCL	178.3
95% Standard Bootstrap UCL	178	95% Bootstrap-t UCL	187.3
95% Hall's Bootstrap UCL	186.9	95% Percentile Bootstrap UCL	179
95% BCA Bootstrap UCL	188.3		
90% Chebyshev(Mean, Sd) UCL	204.1	95% Chebyshev(Mean, Sd) UCL	230.3
97.5% Chebyshev(Mean, Sd) UCL	266.8	99% Chebyshev(Mean, Sd) UCL	338.3

Suggested UCL to Use

95% Approximate Gamma UCL 178.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lithium (mg/kg)

General Statistics

Total Number of Observations	24	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	23	Mean	48.79
Maximum	82	Median	47.5
SD	16.91	Std. Error of Mean	3.452
Coefficient of Variation	0.347	Skewness	0.197

Normal GOF Test

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0727	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	54.71	95% Adjusted-CLT UCL (Chen-1995)	54.62
		95% Modified-t UCL (Johnson-1978)	54.73

Gamma GOF Test

A-D Test Statistic	0.247	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0879	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	8.126	k star (bias corrected MLE)	7.138
Theta hat (MLE)	6.004	Theta star (bias corrected MLE)	6.835
nu hat (MLE)	390.1	nu star (bias corrected)	342.6
MLE Mean (bias corrected)	48.79	MLE Sd (bias corrected)	18.26
		Approximate Chi Square Value (0.05)	300.7
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	298

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	55.59	95% Adjusted Gamma UCL (use when n<50)	56.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.108	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.177	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.135	Mean of logged Data	3.825
Maximum of Logged Data	4.407	SD of logged Data	0.372

Assuming Lognormal Distribution

95% H-UCL	56.82	90% Chebyshev (MVUE) UCL	60.38
95% Chebyshev (MVUE) UCL	65.56	97.5% Chebyshev (MVUE) UCL	72.74
99% Chebyshev (MVUE) UCL	86.84		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	54.47	95% Jackknife UCL	54.71
95% Standard Bootstrap UCL	54.44	95% Bootstrap-t UCL	54.49
95% Hall's Bootstrap UCL	54.86	95% Percentile Bootstrap UCL	54.5
95% BCA Bootstrap UCL	54.21		
90% Chebyshev(Mean, Sd) UCL	59.15	95% Chebyshev(Mean, Sd) UCL	63.84
97.5% Chebyshev(Mean, Sd) UCL	70.35	99% Chebyshev(Mean, Sd) UCL	83.14

Suggested UCL to Use

95% Student's-t UCL	54.71

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Manganese (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	35
		Number of Missing Observations	0
Minimum	220	Mean	936.2
Maximum	2500	Median	855
SD	497.6	Std. Error of Mean	73.36
Coefficient of Variation	0.531	Skewness	0.983

Normal GOF Test

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.132	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1059	95% Adjusted-CLT UCL (Chen-1995)	1068
		95% Modified-t UCL (Johnson-1978)	1061

Gamma GOF Test

A-D Test Statistic	0.188	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0868	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.131	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.723	k star (bias corrected MLE)	3.495
Theta hat (MLE)	251.4	Theta star (bias corrected MLE)	267.8
nu hat (MLE)	342.6	nu star (bias corrected)	321.5
MLE Mean (bias corrected)	936.2	MLE Sd (bias corrected)	500.7
		Approximate Chi Square Value (0.05)	281
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	279.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1071	95% Adjusted Gamma UCL (use when n<50)	1076

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0777	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.129	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.394	Mean of logged Data	6.702
Maximum of Logged Data	7.824	SD of logged Data	0.55

Assuming Lognormal Distribution

95% H-UCL	1108	90% Chebyshev (MVUE) UCL	1186
95% Chebyshev (MVUE) UCL	1296	97.5% Chebyshev (MVUE) UCL	1449
99% Chebyshev (MVUE) UCL	1749		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1057	95% Jackknife UCL	1059
95% Standard Bootstrap UCL	1056	95% Bootstrap-t UCL	1072
95% Hall's Bootstrap UCL	1074	95% Percentile Bootstrap UCL	1056
95% BCA Bootstrap UCL	1072		
90% Chebyshev(Mean, Sd) UCL	1156	95% Chebyshev(Mean, Sd) UCL	1256
97.5% Chebyshev(Mean, Sd) UCL	1394	99% Chebyshev(Mean, Sd) UCL	1666

Suggested UCL to Use

95% Adjusted Gamma UCL 1076

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	24	Number of Distinct Observations	12
Number of Detects	23	Number of Non-Detects	1
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	0.02	Minimum Non-Detect	0.3
Maximum Detect	0.29	Maximum Non-Detect	0.3
Variance Detects	0.00378	Percent Non-Detects	4.167%
Mean Detects	0.073	SD Detects	0.0615
Median Detects	0.05	CV Detects	0.841
Skewness Detects	2.263	Kurtosis Detects	6.293
Mean of Logged Detects	-2.866	SD of Logged Detects	0.689

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.748	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.255	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.18	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.073	KM Standard Error of Mean	0.0128
KM SD	0.0601	95% KM (BCA) UCL	0.0952
95% KM (t) UCL	0.095	95% KM (Percentile Bootstrap) UCL	0.0963
95% KM (z) UCL	0.0941	95% KM Bootstrap t UCL	0.108
90% KM Chebyshev UCL	0.111	95% KM Chebyshev UCL	0.129
97.5% KM Chebyshev UCL	0.153	99% KM Chebyshev UCL	0.201

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.767	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.223	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.184	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.161	k star (bias corrected MLE)	1.908
Theta hat (MLE)	0.0338	Theta star (bias corrected MLE)	0.0383
nu hat (MLE)	99.43	nu star (bias corrected)	87.79
Mean (detects)	0.073		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.02	Mean	0.0726
Maximum	0.29	Median	0.05
SD	0.0601	CV	0.829
k hat (MLE)	2.245	k star (bias corrected MLE)	1.992
Theta hat (MLE)	0.0323	Theta star (bias corrected MLE)	0.0364
nu hat (MLE)	107.7	nu star (bias corrected)	95.61
Adjusted Level of Significance (β)	0.0392		
Approximate Chi Square Value (95.61, α)	74.05	Adjusted Chi Square Value (95.61, β)	72.72
95% Gamma Approximate UCL (use when n>=50)	0.0937	95% Gamma Adjusted UCL (use when n<50)	0.0954

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.073	SD (KM)	0.0601
Variance (KM)	0.00361	SE of Mean (KM)	0.0128
k hat (KM)	1.477	k star (KM)	1.32
nu hat (KM)	70.89	nu star (KM)	63.36
theta hat (KM)	0.0495	theta star (KM)	0.0553
80% gamma percentile (KM)	0.115	90% gamma percentile (KM)	0.157
95% gamma percentile (KM)	0.199	99% gamma percentile (KM)	0.293

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (63.36, α)	46.05	Adjusted Chi Square Value (63.36, β)	45.01
95% Gamma Approximate KM-UCL (use when n>=50)	0.101	95% Gamma Adjusted KM-UCL (use when n<50)	0.103

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.184	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0724	Mean in Log Scale	-2.866
SD in Original Scale	0.0602	SD in Log Scale	0.674
95% t UCL (assumes normality of ROS data)	0.0934	95% Percentile Bootstrap UCL	0.0938
95% BCA Bootstrap UCL	0.0983	95% Bootstrap t UCL	0.106
95% H-UCL (Log ROS)	0.0967		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.866	KM Geo Mean	0.057
KM SD (logged)	0.674	95% Critical H Value (KM-Log)	2.15
KM Standard Error of Mean (logged)	0.144	95% H-UCL (KM -Log)	0.0967
KM SD (logged)	0.674	95% Critical H Value (KM-Log)	2.15
KM Standard Error of Mean (logged)	0.144		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0763	Mean in Log Scale	-2.825
SD in Original Scale	0.0621	SD in Log Scale	0.702
95% t UCL (Assumes normality)	0.098	95% H-Stat UCL	0.104

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.0967

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/kg)

General Statistics

Total Number of Observations	40	Number of Distinct Observations	8
Number of Detects	13	Number of Non-Detects	27
Number of Distinct Detects	7	Number of Distinct Non-Detects	3
Minimum Detect	1	Minimum Non-Detect	1
Maximum Detect	4	Maximum Non-Detect	5
Variance Detects	0.731	Percent Non-Detects	67.5%
Mean Detects	1.569	SD Detects	0.855
Median Detects	1.2	CV Detects	0.545
Skewness Detects	2.13	Kurtosis Detects	5.298
Mean of Logged Detects	0.35	SD of Logged Detects	0.437

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.707	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.234	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.194	KM Standard Error of Mean	0.0913
KM SD	0.546	95% KM (BCA) UCL	1.359
95% KM (t) UCL	1.348	95% KM (Percentile Bootstrap) UCL	1.347
95% KM (z) UCL	1.344	95% KM Bootstrap t UCL	1.507
90% KM Chebyshev UCL	1.468	95% KM Chebyshev UCL	1.592
97.5% KM Chebyshev UCL	1.765	99% KM Chebyshev UCL	2.103

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.144	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.736	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.237	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.12	k star (bias corrected MLE)	3.99
Theta hat (MLE)	0.306	Theta star (bias corrected MLE)	0.393
nu hat (MLE)	133.1	nu star (bias corrected)	103.7
Mean (detects)	1.569		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.594
Maximum	4	Median	0.181
SD	0.851	CV	1.433
k hat (MLE)	0.391	k star (bias corrected MLE)	0.378
Theta hat (MLE)	1.519	Theta star (bias corrected MLE)	1.57
nu hat (MLE)	31.28	nu star (bias corrected)	30.27
Adjusted Level of Significance (β)	0.044		
Approximate Chi Square Value (30.27, α)	18.7	Adjusted Chi Square Value (30.27, β)	18.36
95% Gamma Approximate UCL (use when n>=50)	0.961	95% Gamma Adjusted UCL (use when n<50)	0.979

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.194	SD (KM)	0.546
Variance (KM)	0.298	SE of Mean (KM)	0.0913
k hat (KM)	4.789	k star (KM)	4.446
nu hat (KM)	383.1	nu star (KM)	355.7
theta hat (KM)	0.249	theta star (KM)	0.269
80% gamma percentile (KM)	1.626	90% gamma percentile (KM)	1.953
95% gamma percentile (KM)	2.252	99% gamma percentile (KM)	2.887

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (355.72, α)	313	Adjusted Chi Square Value (355.72, β)	311.5
95% Gamma Approximate KM-UCL (use when n>=50)	1.357	95% Gamma Adjusted KM-UCL (use when n<50)	1.363

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.8	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.25	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.234	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.818	Mean in Log Scale	-0.492
SD in Original Scale	0.73	SD in Log Scale	0.761
95% t UCL (assumes normality of ROS data)	1.012	95% Percentile Bootstrap UCL	1.019
95% BCA Bootstrap UCL	1.1	95% Bootstrap t UCL	1.099
95% H-UCL (Log ROS)	1.061		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.12	KM Geo Mean	1.128
KM SD (logged)	0.294	95% Critical H Value (KM-Log)	1.788
KM Standard Error of Mean (logged)	0.0495	95% H-UCL (KM -Log)	1.281
KM SD (logged)	0.294	95% Critical H Value (KM-Log)	1.788
KM Standard Error of Mean (logged)	0.0495		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.948	Mean in Log Scale	-0.245
SD in Original Scale	0.727	SD in Log Scale	0.575
95% t UCL (Assumes normality)	1.141	95% H-Stat UCL	1.109

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.348	KM H-UCL	1.281
95% KM (BCA) UCL	1.359		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	31
		Number of Missing Observations	0
Minimum	11	Mean	32.8
Maximum	89	Median	30
SD	14.86	Std. Error of Mean	2.191
Coefficient of Variation	0.453	Skewness	1.464

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.109	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.129	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	36.48	95% Adjusted-CLT UCL (Chen-1995)	36.91
		95% Modified-t UCL (Johnson-1978)	36.56

Gamma GOF Test

A-D Test Statistic	0.333	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0776	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.131	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.457	k star (bias corrected MLE)	5.116
Theta hat (MLE)	6.012	Theta star (bias corrected MLE)	6.413
nu hat (MLE)	502	nu star (bias corrected)	470.6
MLE Mean (bias corrected)	32.8	MLE Sd (bias corrected)	14.5
		Approximate Chi Square Value (0.05)	421.3
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	419.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	36.64	95% Adjusted Gamma UCL (use when n<50)	36.77

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0915	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.129	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.398	Mean of logged Data	3.396
Maximum of Logged Data	4.489	SD of logged Data	0.445

Assuming Lognormal Distribution

95% H-UCL	37.27	90% Chebyshev (MVUE) UCL	39.62
95% Chebyshev (MVUE) UCL	42.67	97.5% Chebyshev (MVUE) UCL	46.9
99% Chebyshev (MVUE) UCL	55.22		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	36.41	95% Jackknife UCL	36.48
95% Standard Bootstrap UCL	36.47	95% Bootstrap-t UCL	37.11
95% Hall's Bootstrap UCL	37.52	95% Percentile Bootstrap UCL	36.48
95% BCA Bootstrap UCL	36.92		
90% Chebyshev(Mean, Sd) UCL	39.38	95% Chebyshev(Mean, Sd) UCL	42.36
97.5% Chebyshev(Mean, Sd) UCL	46.49	99% Chebyshev(Mean, Sd) UCL	54.61

Suggested UCL to Use

95% Student's-t UCL 36.48

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Phosphorus (mg/kg)

General Statistics

Total Number of Observations	24	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	550	Mean	858.8
Maximum	1700	Median	770
SD	294.9	Std. Error of Mean	60.19
Coefficient of Variation	0.343	Skewness	1.845

Normal GOF Test

Shapiro Wilk Test Statistic	0.776	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.264	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	961.9	95% Adjusted-CLT UCL (Chen-1995)	982
		95% Modified-t UCL (Johnson-1978)	965.7

Gamma GOF Test

A-D Test Statistic	1.286	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.744	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.217	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.178	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	11.35	k star (bias corrected MLE)	9.962
Theta hat (MLE)	75.64	Theta star (bias corrected MLE)	86.2
nu hat (MLE)	545	nu star (bias corrected)	478.2
MLE Mean (bias corrected)	858.8	MLE Sd (bias corrected)	272.1
		Approximate Chi Square Value (0.05)	428.5
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	425.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	958.4	95% Adjusted Gamma UCL (use when n<50)	965.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.881	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.195	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.177	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.31	Mean of logged Data	6.711
Maximum of Logged Data	7.438	SD of logged Data	0.289

Assuming Lognormal Distribution

95% H-UCL	955.7	90% Chebyshev (MVUE) UCL	1008
95% Chebyshev (MVUE) UCL	1078	97.5% Chebyshev (MVUE) UCL	1175
99% Chebyshev (MVUE) UCL	1364		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	957.8	95% Jackknife UCL	961.9
95% Standard Bootstrap UCL	956.6	95% Bootstrap-t UCL	1007
95% Hall's Bootstrap UCL	1029	95% Percentile Bootstrap UCL	959.2
95% BCA Bootstrap UCL	980.8		
90% Chebyshev(Mean, Sd) UCL	1039	95% Chebyshev(Mean, Sd) UCL	1121
97.5% Chebyshev(Mean, Sd) UCL	1235	99% Chebyshev(Mean, Sd) UCL	1458

Suggested UCL to Use

95% Student's-t UCL	961.9	or 95% Modified-t UCL	965.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Selenium (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	20
Number of Detects	30	Number of Non-Detects	16
Number of Distinct Detects	16	Number of Distinct Non-Detects	5
Minimum Detect	0.6	Minimum Non-Detect	2.5
Maximum Detect	5	Maximum Non-Detect	5.85
Variance Detects	1.078	Percent Non-Detects	34.78%
Mean Detects	1.453	SD Detects	1.038
Median Detects	1	CV Detects	0.715
Skewness Detects	1.895	Kurtosis Detects	3.535
Mean of Logged Detects	0.196	SD of Logged Detects	0.561

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.723	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.3	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.316	KM Standard Error of Mean	0.142
KM SD	0.892	95% KM (BCA) UCL	1.583
95% KM (t) UCL	1.555	95% KM (Percentile Bootstrap) UCL	1.558
95% KM (z) UCL	1.55	95% KM Bootstrap t UCL	1.625
90% KM Chebyshev UCL	1.743	95% KM Chebyshev UCL	1.936
97.5% KM Chebyshev UCL	2.205	99% KM Chebyshev UCL	2.732

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.556	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.269	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.161	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.972	k star (bias corrected MLE)	2.697
Theta hat (MLE)	0.489	Theta star (bias corrected MLE)	0.539
nu hat (MLE)	178.3	nu star (bias corrected)	161.8
Mean (detects)	1.453		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	0.239	Mean	1.322
Maximum	5	Median	1
SD	0.895	CV	0.677
k hat (MLE)	3.164	k star (bias corrected MLE)	2.972
Theta hat (MLE)	0.418	Theta star (bias corrected MLE)	0.445
nu hat (MLE)	291.1	nu star (bias corrected)	273.4
Adjusted Level of Significance (β)	0.0448		
Approximate Chi Square Value (273.43, α)	236.1	Adjusted Chi Square Value (273.43, β)	235
95% Gamma Approximate UCL (use when n>=50)	1.531	95% Gamma Adjusted UCL (use when n<50)	1.538

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.316	SD (KM)	0.892
Variance (KM)	0.795	SE of Mean (KM)	0.142
k hat (KM)	2.176	k star (KM)	2.049
nu hat (KM)	200.2	nu star (KM)	188.5
theta hat (KM)	0.604	theta star (KM)	0.642
80% gamma percentile (KM)	1.964	90% gamma percentile (KM)	2.544
95% gamma percentile (KM)	3.097	99% gamma percentile (KM)	4.321

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (188.50, α)	157.7	Adjusted Chi Square Value (188.50, β)	156.8
95% Gamma Approximate KM-UCL (use when n>=50)	1.572	95% Gamma Adjusted KM-UCL (use when n<50)	1.581

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.927	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.159	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.325	Mean in Log Scale	0.141
SD in Original Scale	0.873	SD in Log Scale	0.492
95% t UCL (assumes normality of ROS data)	1.542	95% Percentile Bootstrap UCL	1.554
95% BCA Bootstrap UCL	1.575	95% Bootstrap t UCL	1.629
95% H-UCL (Log ROS)	1.492		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.124	KM Geo Mean	1.132
KM SD (logged)	0.498	95% Critical H Value (KM-Log)	1.882
KM Standard Error of Mean (logged)	0.0828	95% H-UCL (KM -Log)	1.473
KM SD (logged)	0.498	95% Critical H Value (KM-Log)	1.882
KM Standard Error of Mean (logged)	0.0828		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.457	Mean in Log Scale	0.248
SD in Original Scale	0.881	SD in Log Scale	0.48
95% t UCL (Assumes normality)	1.675	95% H-Stat UCL	1.643

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (Chebyshev) UCL 1.936

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silica (as SIO2) (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	96	Mean	1635
Maximum	5600	Median	1500
SD	1151	Std. Error of Mean	264.1
Coefficient of Variation	0.704	Skewness	2.408

Normal GOF Test

Shapiro Wilk Test Statistic	0.758	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2093	95% Adjusted-CLT UCL (Chen-1995)	2225
		95% Modified-t UCL (Johnson-1978)	2117

Gamma GOF Test

A-D Test Statistic	0.839	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.199	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.201	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.32	k star (bias corrected MLE)	1.989
Theta hat (MLE)	704.6	Theta star (bias corrected MLE)	822
nu hat (MLE)	88.18	nu star (bias corrected)	75.59
MLE Mean (bias corrected)	1635	MLE Sd (bias corrected)	1159
		Approximate Chi Square Value (0.05)	56.56
Adjusted Level of Significance	0.0369	Adjusted Chi Square Value	55.12

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2185	95% Adjusted Gamma UCL (use when n<50)	2242

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.825	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.901	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.197	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.564	Mean of logged Data	7.169
Maximum of Logged Data	8.631	SD of logged Data	0.801

Assuming Lognormal Distribution

95% H-UCL	2787	90% Chebyshev (MVUE) UCL	2797
95% Chebyshev (MVUE) UCL	3271	97.5% Chebyshev (MVUE) UCL	3928
99% Chebyshev (MVUE) UCL	5218		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2069	95% Jackknife UCL	2093
95% Standard Bootstrap UCL	2057	95% Bootstrap-t UCL	2424
95% Hall's Bootstrap UCL	4422	95% Percentile Bootstrap UCL	2074
95% BCA Bootstrap UCL	2272		
90% Chebyshev(Mean, Sd) UCL	2427	95% Chebyshev(Mean, Sd) UCL	2786
97.5% Chebyshev(Mean, Sd) UCL	3284	99% Chebyshev(Mean, Sd) UCL	4262

Suggested UCL to Use

95% Adjusted Gamma UCL 2242

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	6
Number of Detects	1	Number of Non-Detects	44
Number of Distinct Detects	1	Number of Distinct Non-Detects	5

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Silver (mg/kg) was not processed!

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Strontium (mg/kg)

General Statistics

Total Number of Observations	24	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	58	Mean	99.46
Maximum	140	Median	99.5
SD	23.91	Std. Error of Mean	4.881
Coefficient of Variation	0.24	Skewness	-0.0897

Normal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.129	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	107.8	95% Adjusted-CLT UCL (Chen-1995)	107.4
		95% Modified-t UCL (Johnson-1978)	107.8

Gamma GOF Test

A-D Test Statistic	0.439	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.151	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	16.96	k star (bias corrected MLE)	14.87
Theta hat (MLE)	5.864	Theta star (bias corrected MLE)	6.689
nu hat (MLE)	814.2	nu star (bias corrected)	713.7
MLE Mean (bias corrected)	99.46	MLE Sd (bias corrected)	25.79
		Approximate Chi Square Value (0.05)	652.7
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	648.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	108.8	95% Adjusted Gamma UCL (use when n<50)	109.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.916	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.154	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.177	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.06	Mean of logged Data	4.57
Maximum of Logged Data	4.942	SD of logged Data	0.254

Assuming Lognormal Distribution

95% H-UCL	109.7	90% Chebyshev (MVUE) UCL	115.3
95% Chebyshev (MVUE) UCL	122.4	97.5% Chebyshev (MVUE) UCL	132.2
99% Chebyshev (MVUE) UCL	151.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	107.5	95% Jackknife UCL	107.8
95% Standard Bootstrap UCL	107.5	95% Bootstrap-t UCL	107.6
95% Hall's Bootstrap UCL	107.3	95% Percentile Bootstrap UCL	107.5
95% BCA Bootstrap UCL	107.1		
90% Chebyshev(Mean, Sd) UCL	114.1	95% Chebyshev(Mean, Sd) UCL	120.7
97.5% Chebyshev(Mean, Sd) UCL	129.9	99% Chebyshev(Mean, Sd) UCL	148

Suggested UCL to Use

95% Student's-t UCL 107.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Thallium (mg/kg)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	7
Number of Detects	1	Number of Non-Detects	45
Number of Distinct Detects	1	Number of Distinct Non-Detects	6

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Thallium (mg/kg) was not processed!

Titanium (mg/kg)

General Statistics

Total Number of Observations	24	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.36	Mean	0.486
Maximum	0.53	Median	0.5
SD	0.0411	Std. Error of Mean	0.00838
Coefficient of Variation	0.0844	Skewness	-1.393

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.863	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.214	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.501	95% Adjusted-CLT UCL (Chen-1995)	0.497
		95% Modified-t UCL (Johnson-1978)	0.5

Gamma GOF Test

A-D Test Statistic	1.098	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.221	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.177	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	134.2	k star (bias corrected MLE)	117.5
Theta hat (MLE)	0.00362	Theta star (bias corrected MLE)	0.00414
nu hat (MLE)	6444	nu star (bias corrected)	5640
MLE Mean (bias corrected)	0.486	MLE Sd (bias corrected)	0.0449
		Approximate Chi Square Value (0.05)	5466
Adjusted Level of Significance	0.0392	Adjusted Chi Square Value	5454

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.502	95% Adjusted Gamma UCL (use when n<50)	0.503

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.83	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.22	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.177	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.022	Mean of logged Data	-0.725
Maximum of Logged Data	-0.635	SD of logged Data	0.0903

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	0.513
95% Chebyshev (MVUE) UCL	0.525	97.5% Chebyshev (MVUE) UCL	0.542
99% Chebyshev (MVUE) UCL	0.576		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	0.5	95% Jackknife UCL	0.501
95% Standard Bootstrap UCL	0.5	95% Bootstrap-t UCL	0.498
95% Hall's Bootstrap UCL	0.498	95% Percentile Bootstrap UCL	0.499
95% BCA Bootstrap UCL	0.498		
90% Chebyshev(Mean, Sd) UCL	0.511	95% Chebyshev(Mean, Sd) UCL	0.523
97.5% Chebyshev(Mean, Sd) UCL	0.539	99% Chebyshev(Mean, Sd) UCL	0.57

Suggested UCL to Use

95% Student's-t UCL	0.501	or 95% Modified-t UCL	0.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	37
		Number of Missing Observations	0
Minimum	11	Mean	60.34
Maximum	130	Median	58
SD	34.39	Std. Error of Mean	5.126
Coefficient of Variation	0.57	Skewness	0.231

Normal GOF Test

Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	68.96	95% Adjusted-CLT UCL (Chen-1995)	68.96
		95% Modified-t UCL (Johnson-1978)	68.99

Gamma GOF Test

A-D Test Statistic	1.027	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.757	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.152	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.133	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	2.63	k star (bias corrected MLE)	2.469
Theta hat (MLE)	22.94	Theta star (bias corrected MLE)	24.44
nu hat (MLE)	236.7	nu star (bias corrected)	222.3
MLE Mean (bias corrected)	60.34	MLE Sd (bias corrected)	38.4
		Approximate Chi Square Value (0.05)	188.7
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	187.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	71.06	95% Adjusted Gamma UCL (use when n<50)	71.44

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.158	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.131	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.398	Mean of logged Data	3.898
Maximum of Logged Data	4.868	SD of logged Data	0.691

Assuming Lognormal Distribution

95% H-UCL	77.6	90% Chebyshev (MVUE) UCL	83.12
95% Chebyshev (MVUE) UCL	92.6	97.5% Chebyshev (MVUE) UCL	105.8
99% Chebyshev (MVUE) UCL	131.6		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	68.78	95% Jackknife UCL	68.96
95% Standard Bootstrap UCL	68.56	95% Bootstrap-t UCL	69.34
95% Hall's Bootstrap UCL	69.14	95% Percentile Bootstrap UCL	68.46
95% BCA Bootstrap UCL	68.89		
90% Chebyshev(Mean, Sd) UCL	75.72	95% Chebyshev(Mean, Sd) UCL	82.69
97.5% Chebyshev(Mean, Sd) UCL	92.36	99% Chebyshev(Mean, Sd) UCL	111.3

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	82.69

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Zinc (mg/kg)

General Statistics

Total Number of Observations	66	Number of Distinct Observations	57
		Number of Missing Observations	0
Minimum	61	Mean	2025
Maximum	16000	Median	1475
SD	2931	Std. Error of Mean	360.8
Coefficient of Variation	1.447	Skewness	3.132

Normal GOF Test

Shapiro Wilk Test Statistic	0.613	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.296	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.109	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2627	95% Adjusted-CLT UCL (Chen-1995)	2767
		95% Modified-t UCL (Johnson-1978)	2650

Gamma GOF Test

A-D Test Statistic	1.561	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.79	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.145	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.114	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.799	k star (bias corrected MLE)	0.773
Theta hat (MLE)	2535	Theta star (bias corrected MLE)	2621
nu hat (MLE)	105.5	nu star (bias corrected)	102
MLE Mean (bias corrected)	2025	MLE Sd (bias corrected)	2304
		Approximate Chi Square Value (0.05)	79.7
Adjusted Level of Significance	0.0464	Adjusted Chi Square Value	79.26

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2592	95% Adjusted Gamma UCL (use when n<50)	2606

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.025	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.109	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.111	Mean of logged Data	6.87
Maximum of Logged Data	9.68	SD of logged Data	1.285

Appendix D, Table 6. ProUCL Output - Lower Spring River Sediment (Sieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	3111	90% Chebyshev (MVUE) UCL	3461
95% Chebyshev (MVUE) UCL	4053	97.5% Chebyshev (MVUE) UCL	4876
99% Chebyshev (MVUE) UCL	6493		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2618	95% Jackknife UCL	2627
95% Standard Bootstrap UCL	2605	95% Bootstrap-t UCL	2879
95% Hall's Bootstrap UCL	2817	95% Percentile Bootstrap UCL	2641
95% BCA Bootstrap UCL	2745		
90% Chebyshev(Mean, Sd) UCL	3107	95% Chebyshev(Mean, Sd) UCL	3598
97.5% Chebyshev(Mean, Sd) UCL	4278	99% Chebyshev(Mean, Sd) UCL	5615

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 3598

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:11:05 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	1140	Mean	7069
Maximum	15600	Median	6910
SD	3380	Std. Error of Mean	627.7
Coefficient of Variation	0.478	Skewness	0.618

Normal GOF Test

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.135	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8137	95% Adjusted-CLT UCL (Chen-1995)	8179
		95% Modified-t UCL (Johnson-1978)	8149

Gamma GOF Test

A-D Test Statistic	0.222	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.103	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.163	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.041	k star (bias corrected MLE)	3.646
Theta hat (MLE)	1750	Theta star (bias corrected MLE)	1939
nu hat (MLE)	234.4	nu star (bias corrected)	211.4
MLE Mean (bias corrected)	7069	MLE Sd (bias corrected)	3703
		Approximate Chi Square Value (0.05)	178.8
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	177

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8360	95% Adjusted Gamma UCL (use when n<50)	8445

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.133	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.161	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.039	Mean of logged Data	8.735
Maximum of Logged Data	9.655	SD of logged Data	0.557

Assuming Lognormal Distribution

95% H-UCL	8957	90% Chebyshev (MVUE) UCL	9575
95% Chebyshev (MVUE) UCL	10644	97.5% Chebyshev (MVUE) UCL	12128
99% Chebyshev (MVUE) UCL	15043		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8102	95% Jackknife UCL	8137
95% Standard Bootstrap UCL	8084	95% Bootstrap-t UCL	8218
95% Hall's Bootstrap UCL	8223	95% Percentile Bootstrap UCL	8107
95% BCA Bootstrap UCL	8125		
90% Chebyshev(Mean, Sd) UCL	8952	95% Chebyshev(Mean, Sd) UCL	9805
97.5% Chebyshev(Mean, Sd) UCL	10989	99% Chebyshev(Mean, Sd) UCL	13315

Suggested UCL to Use

95% Student's-t UCL 8137

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	25
Number of Detects	12	Number of Non-Detects	17
Number of Distinct Detects	12	Number of Distinct Non-Detects	15
Minimum Detect	0.48	Minimum Non-Detect	0.6
Maximum Detect	9.17	Maximum Non-Detect	18
Variance Detects	9.191	Percent Non-Detects	58.62%
Mean Detects	3.271	SD Detects	3.032
Median Detects	1.65	CV Detects	0.927
Skewness Detects	0.968	Kurtosis Detects	-0.34
Mean of Logged Detects	0.74	SD of Logged Detects	1.02

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.834	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.423	KM Standard Error of Mean	0.654
KM SD	2.641	95% KM (BCA) UCL	3.599
95% KM (t) UCL	3.536	95% KM (Percentile Bootstrap) UCL	3.536
95% KM (z) UCL	3.499	95% KM Bootstrap t UCL	3.881
90% KM Chebyshev UCL	4.386	95% KM Chebyshev UCL	5.275
97.5% KM Chebyshev UCL	6.508	99% KM Chebyshev UCL	8.932

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.541	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.199	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.251	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.263	k star (bias corrected MLE)	1.003
Theta hat (MLE)	2.59	Theta star (bias corrected MLE)	3.262
nu hat (MLE)	30.31	nu star (bias corrected)	24.07
Mean (detects)	3.271		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.007
Maximum	9.17	Median	1.367
SD	2.258	CV	1.125
k hat (MLE)	0.69	k star (bias corrected MLE)	0.641
Theta hat (MLE)	2.91	Theta star (bias corrected MLE)	3.129
nu hat (MLE)	40	nu star (bias corrected)	37.2
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (37.20, α)	24.23	Adjusted Chi Square Value (37.20, β)	23.61
95% Gamma Approximate UCL (use when n>=50)	3.08	95% Gamma Adjusted UCL (use when n<50)	3.162

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.423	SD (KM)	2.641
Variance (KM)	6.977	SE of Mean (KM)	0.654
k hat (KM)	0.842	k star (KM)	0.778
nu hat (KM)	48.82	nu star (KM)	45.11
theta hat (KM)	2.879	theta star (KM)	3.116
80% gamma percentile (KM)	3.966	90% gamma percentile (KM)	5.933
95% gamma percentile (KM)	7.942	99% gamma percentile (KM)	12.7

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (45.11, α)	30.7	Adjusted Chi Square Value (45.11, β)	29.99
95% Gamma Approximate KM-UCL (use when n>=50)	3.561	95% Gamma Adjusted KM-UCL (use when n<50)	3.645

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.923	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.183	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.964	Mean in Log Scale	0.261
SD in Original Scale	2.231	SD in Log Scale	0.864
95% t UCL (assumes normality of ROS data)	2.669	95% Percentile Bootstrap UCL	2.705
95% BCA Bootstrap UCL	2.857	95% Bootstrap t UCL	3.083
95% H-UCL (Log ROS)	2.748		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.332	KM Geo Mean	1.394
KM SD (logged)	1.029	95% Critical H Value (KM-Log)	2.503
KM Standard Error of Mean (logged)	0.263	95% H-UCL (KM -Log)	3.852
KM SD (logged)	1.029	95% Critical H Value (KM-Log)	2.503
KM Standard Error of Mean (logged)	0.263		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.682	Mean in Log Scale	0.872
SD in Original Scale	2.657	SD in Log Scale	1.113
95% t UCL (Assumes normality)	4.521	95% H-Stat UCL	7.696

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	3.645	95% GROS Adjusted Gamma UCL	3.162

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	26
Number of Detects	28	Number of Non-Detects	1
Number of Distinct Detects	25	Number of Distinct Non-Detects	1

Minimum Detect	2.2	Minimum Non-Detect	0.6
Maximum Detect	33.6	Maximum Non-Detect	0.6
Variance Detects	47.1	Percent Non-Detects	3.448%
Mean Detects	8.539	SD Detects	6.863
Median Detects	5.74	CV Detects	0.804
Skewness Detects	2.306	Kurtosis Detects	5.961
Mean of Logged Detects	1.931	SD of Logged Detects	0.623

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.727	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.252	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	8.266	KM Standard Error of Mean	1.282
KM SD	6.779	95% KM (BCA) UCL	10.72
95% KM (t) UCL	10.45	95% KM (Percentile Bootstrap) UCL	10.52
95% KM (z) UCL	10.37	95% KM Bootstrap t UCL	11.55
90% KM Chebyshev UCL	12.11	95% KM Chebyshev UCL	13.85
97.5% KM Chebyshev UCL	16.27	99% KM Chebyshev UCL	21.02

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.343	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.756	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.202	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.167	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.49	k star (bias corrected MLE)	2.247
Theta hat (MLE)	3.43	Theta star (bias corrected MLE)	3.801
nu hat (MLE)	139.4	nu star (bias corrected)	125.8
Mean (detects)	8.539		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	8.245
Maximum	33.6	Median	5.6
SD	6.923	CV	0.84
k hat (MLE)	1.379	k star (bias corrected MLE)	1.26
Theta hat (MLE)	5.978	Theta star (bias corrected MLE)	6.546
nu hat (MLE)	80	nu star (bias corrected)	73.06
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (73.06, α)	54.37	Adjusted Chi Square Value (73.06, β)	53.41
95% Gamma Approximate UCL (use when n>=50)	11.08	95% Gamma Adjusted UCL (use when n<50)	11.28

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	8.266	SD (KM)	6.779
Variance (KM)	45.95	SE of Mean (KM)	1.282
k hat (KM)	1.487	k star (KM)	1.356
nu hat (KM)	86.23	nu star (KM)	78.64
theta hat (KM)	5.56	theta star (KM)	6.096
80% gamma percentile (KM)	12.93	90% gamma percentile (KM)	17.65
95% gamma percentile (KM)	22.28	99% gamma percentile (KM)	32.78

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (78.64, α)	59.21	Adjusted Chi Square Value (78.64, β)	58.2
95% Gamma Approximate KM-UCL (use when n>=50)	10.98	95% Gamma Adjusted KM-UCL (use when n<50)	11.17

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.165	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.164	Detected Data Not Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	8.296	Mean in Log Scale	1.878
SD in Original Scale	6.866	SD in Log Scale	0.675
95% t UCL (assumes normality of ROS data)	10.46	95% Percentile Bootstrap UCL	10.56
95% BCA Bootstrap UCL	11	95% Bootstrap t UCL	11.55
95% H-UCL (Log ROS)	10.74		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.846	KM Geo Mean	6.337
KM SD (logged)	0.749	95% Critical H Value (KM-Log)	2.178
KM Standard Error of Mean (logged)	0.142	95% H-UCL (KM -Log)	11.41
KM SD (logged)	0.749	95% Critical H Value (KM-Log)	2.178
KM Standard Error of Mean (logged)	0.142		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	8.255	Mean in Log Scale	1.823
SD in Original Scale	6.911	SD in Log Scale	0.845
95% t UCL (Assumes normality)	10.44	95% H-Stat UCL	12.73

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 11.41

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Barium (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	6.9	Mean	85.3
Maximum	269	Median	82.9
SD	48.95	Std. Error of Mean	9.089
Coefficient of Variation	0.574	Skewness	1.903

Normal GOF Test

Shapiro Wilk Test Statistic	0.859	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.162	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	100.8	95% Adjusted-CLT UCL (Chen-1995)	103.7
		95% Modified-t UCL (Johnson-1978)	101.3

Gamma GOF Test

A-D Test Statistic	0.525	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.115	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.164	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.167	k star (bias corrected MLE)	2.862
Theta hat (MLE)	26.94	Theta star (bias corrected MLE)	29.8
nu hat (MLE)	183.7	nu star (bias corrected)	166
MLE Mean (bias corrected)	85.3	MLE Sd (bias corrected)	50.42
		Approximate Chi Square Value (0.05)	137.2
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	135.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	103.2	95% Adjusted Gamma UCL (use when n<50)	104.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.141	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.161	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.932	Mean of logged Data	4.28
Maximum of Logged Data	5.595	SD of logged Data	0.654

Assuming Lognormal Distribution

95% H-UCL	115.7	90% Chebyshev (MVUE) UCL	123.3
95% Chebyshev (MVUE) UCL	139	97.5% Chebyshev (MVUE) UCL	160.7
99% Chebyshev (MVUE) UCL	203.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	100.3	95% Jackknife UCL	100.8
95% Standard Bootstrap UCL	100	95% Bootstrap-t UCL	107
95% Hall's Bootstrap UCL	116.2	95% Percentile Bootstrap UCL	100.6
95% BCA Bootstrap UCL	103.1		
90% Chebyshev(Mean, Sd) UCL	112.6	95% Chebyshev(Mean, Sd) UCL	124.9
97.5% Chebyshev(Mean, Sd) UCL	142.1	99% Chebyshev(Mean, Sd) UCL	175.7

Suggested UCL to Use

95% Adjusted Gamma UCL 104.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	22
Number of Detects	23	Number of Non-Detects	6
Number of Distinct Detects	18	Number of Distinct Non-Detects	5
Minimum Detect	0.2	Minimum Non-Detect	0.585
Maximum Detect	2.1	Maximum Non-Detect	0.87
Variance Detects	0.234	Percent Non-Detects	20.69%
Mean Detects	0.897	SD Detects	0.483
Median Detects	0.81	CV Detects	0.539
Skewness Detects	0.933	Kurtosis Detects	0.884
Mean of Logged Detects	-0.263	SD of Logged Detects	0.606

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.923	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.193	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.18	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.81	KM Standard Error of Mean	0.0906
KM SD	0.464	95% KM (BCA) UCL	0.968
95% KM (t) UCL	0.964	95% KM (Percentile Bootstrap) UCL	0.958
95% KM (z) UCL	0.959	95% KM Bootstrap t UCL	0.984
90% KM Chebyshev UCL	1.082	95% KM Chebyshev UCL	1.205
97.5% KM Chebyshev UCL	1.376	99% KM Chebyshev UCL	1.711

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.409	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.139	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.183	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.4	k star (bias corrected MLE)	2.986
Theta hat (MLE)	0.264	Theta star (bias corrected MLE)	0.3
nu hat (MLE)	156.4	nu star (bias corrected)	137.3
Mean (detects)	0.897		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.2	Mean	0.804
Maximum	2.1	Median	0.7
SD	0.47	CV	0.584
k hat (MLE)	3.239	k star (bias corrected MLE)	2.927
Theta hat (MLE)	0.248	Theta star (bias corrected MLE)	0.275
nu hat (MLE)	187.8	nu star (bias corrected)	169.7
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (169.75, α)	140.6	Adjusted Chi Square Value (169.75, β)	139
95% Gamma Approximate UCL (use when n>=50)	0.971	95% Gamma Adjusted UCL (use when n<50)	0.982

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.81	SD (KM)	0.464
Variance (KM)	0.216	SE of Mean (KM)	0.0906
k hat (KM)	3.047	k star (KM)	2.754
nu hat (KM)	176.7	nu star (KM)	159.8
theta hat (KM)	0.266	theta star (KM)	0.294
80% gamma percentile (KM)	1.168	90% gamma percentile (KM)	1.465
95% gamma percentile (KM)	1.743	99% gamma percentile (KM)	2.35

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (159.75, α)	131.5	Adjusted Chi Square Value (159.75, β)	130
95% Gamma Approximate KM-UCL (use when n>=50)	0.984	95% Gamma Adjusted KM-UCL (use when n<50)	0.996

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.804	Mean in Log Scale	-0.379
SD in Original Scale	0.469	SD in Log Scale	0.591
95% t UCL (assumes normality of ROS data)	0.952	95% Percentile Bootstrap UCL	0.944
95% BCA Bootstrap UCL	0.973	95% Bootstrap t UCL	0.994
95% H-UCL (Log ROS)	1.023		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.386	KM Geo Mean	0.679
KM SD (logged)	0.627	95% Critical H Value (KM-Log)	2.058
KM Standard Error of Mean (logged)	0.13	95% H-UCL (KM -Log)	1.056
KM SD (logged)	0.627	95% Critical H Value (KM-Log)	2.058
KM Standard Error of Mean (logged)	0.13		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.789	Mean in Log Scale	-0.413
SD in Original Scale	0.48	SD in Log Scale	0.618
95% t UCL (Assumes normality)	0.941	95% H-Stat UCL	1.018

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.964

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	29
Number of Detects	28	Number of Non-Detects	4
Number of Distinct Detects	28	Number of Distinct Non-Detects	1
Minimum Detect	1.1	Minimum Non-Detect	0.08
Maximum Detect	645	Maximum Non-Detect	0.08
Variance Detects	14564	Percent Non-Detects	12.5%
Mean Detects	59.61	SD Detects	120.7
Median Detects	25.35	CV Detects	2.024
Skewness Detects	4.538	Kurtosis Detects	22.29
Mean of Logged Detects	3.143	SD of Logged Detects	1.462

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.44	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.314	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.164	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	52.17	KM Standard Error of Mean	20.27
KM SD	112.6	95% KM (BCA) UCL	93.79
95% KM (t) UCL	86.54	95% KM (Percentile Bootstrap) UCL	91.23
95% KM (z) UCL	85.51	95% KM Bootstrap t UCL	153.3
90% KM Chebyshev UCL	113	95% KM Chebyshev UCL	140.5
97.5% KM Chebyshev UCL	178.7	99% KM Chebyshev UCL	253.8

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.72	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.795	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.153	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.173	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.647	k star (bias corrected MLE)	0.601
Theta hat (MLE)	92.16	Theta star (bias corrected MLE)	99.13
nu hat (MLE)	36.22	nu star (bias corrected)	33.67
Mean (detects)	59.61		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	52.16
Maximum	645	Median	20.35
SD	114.4	CV	2.193
k hat (MLE)	0.374	k star (bias corrected MLE)	0.36
Theta hat (MLE)	139.5	Theta star (bias corrected MLE)	145.1
nu hat (MLE)	23.92	nu star (bias corrected)	23.01
Adjusted Level of Significance (β)	0.0416		
Approximate Chi Square Value (23.01, α)	13.1	Adjusted Chi Square Value (23.01, β)	12.7
95% Gamma Approximate UCL (use when n>=50)	91.63	95% Gamma Adjusted UCL (use when n<50)	94.52

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	52.17	SD (KM)	112.6
Variance (KM)	12676	SE of Mean (KM)	20.27
k hat (KM)	0.215	k star (KM)	0.215
nu hat (KM)	13.74	nu star (KM)	13.79
theta hat (KM)	243	theta star (KM)	242.2
80% gamma percentile (KM)	71.31	90% gamma percentile (KM)	157.7
95% gamma percentile (KM)	263.5	99% gamma percentile (KM)	551.5

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (13.79, α)	6.426	Adjusted Chi Square Value (13.79, β)	6.157
95% Gamma Approximate KM-UCL (use when n>=50)	111.9	95% Gamma Adjusted KM-UCL (use when n<50)	116.8

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0963	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	52.28	Mean in Log Scale	2.731
SD in Original Scale	114.3	SD in Log Scale	1.766
95% t UCL (assumes normality of ROS data)	86.55	95% Percentile Bootstrap UCL	87.95
95% BCA Bootstrap UCL	113.6	95% Bootstrap t UCL	150.5
95% H-UCL (Log ROS)	219.6		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.434	KM Geo Mean	11.41
KM SD (logged)	2.306	95% Critical H Value (KM-Log)	4.306
KM Standard Error of Mean (logged)	0.415	95% H-UCL (KM -Log)	969.6
KM SD (logged)	2.306	95% Critical H Value (KM-Log)	4.306
KM Standard Error of Mean (logged)	0.415		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	52.17	Mean in Log Scale	2.348
SD in Original Scale	114.4	SD in Log Scale	2.536
95% t UCL (Assumes normality)	86.45	95% H-Stat UCL	2187

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1) 116.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	26
		Number of Missing Observations	0
Minimum	6.7	Mean	17.07
Maximum	47.7	Median	11.2
SD	10.78	Std. Error of Mean	2.001
Coefficient of Variation	0.631	Skewness	1.58

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.789	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.926	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.247	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.161	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	20.47	95% Adjusted-CLT UCL (Chen-1995)	20.99
		95% Modified-t UCL (Johnson-1978)	20.57

Gamma GOF Test

A-D Test Statistic	1.487	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.752	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.224	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.164	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.434	k star (bias corrected MLE)	3.102
Theta hat (MLE)	4.97	Theta star (bias corrected MLE)	5.503
nu hat (MLE)	199.2	nu star (bias corrected)	179.9
MLE Mean (bias corrected)	17.07	MLE Sd (bias corrected)	9.691
		Approximate Chi Square Value (0.05)	149.9
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	148.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	20.49	95% Adjusted Gamma UCL (use when n<50)	20.71

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.926	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.21	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.161	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.902	Mean of logged Data	2.685
Maximum of Logged Data	3.865	SD of logged Data	0.535

Assuming Lognormal Distribution

95% H-UCL	20.63	90% Chebyshev (MVUE) UCL	22.06
95% Chebyshev (MVUE) UCL	24.44	97.5% Chebyshev (MVUE) UCL	27.74
99% Chebyshev (MVUE) UCL	34.22		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	20.36	95% Jackknife UCL	20.47
95% Standard Bootstrap UCL	20.32	95% Bootstrap-t UCL	21.49
95% Hall's Bootstrap UCL	21.18	95% Percentile Bootstrap UCL	20.44
95% BCA Bootstrap UCL	21.09		
90% Chebyshev(Mean, Sd) UCL	23.07	95% Chebyshev(Mean, Sd) UCL	25.79
97.5% Chebyshev(Mean, Sd) UCL	29.56	99% Chebyshev(Mean, Sd) UCL	36.98

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 25.79

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	28
Number of Detects	25	Number of Non-Detects	4
Number of Distinct Detects	25	Number of Distinct Non-Detects	3
Minimum Detect	1.4	Minimum Non-Detect	8
Maximum Detect	33.8	Maximum Non-Detect	8.7
Variance Detects	69.88	Percent Non-Detects	13.79%
Mean Detects	12.55	SD Detects	8.359
Median Detects	9.57	CV Detects	0.666
Skewness Detects	1.21	Kurtosis Detects	1.103
Mean of Logged Detects	2.298	SD of Logged Detects	0.757

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.884	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.173	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	11.54	KM Standard Error of Mean	1.54
KM SD	8.057	95% KM (BCA) UCL	14.29
95% KM (t) UCL	14.16	95% KM (Percentile Bootstrap) UCL	14.11
95% KM (z) UCL	14.07	95% KM Bootstrap t UCL	14.69
90% KM Chebyshev UCL	16.16	95% KM Chebyshev UCL	18.25
97.5% KM Chebyshev UCL	21.16	99% KM Chebyshev UCL	26.86

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.367	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.123	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.176	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	2.308	k star (bias corrected MLE)	2.058
Theta hat (MLE)	5.437	Theta star (bias corrected MLE)	6.098
nu hat (MLE)	115.4	nu star (bias corrected)	102.9
Mean (detects)	12.55		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.4	Mean	11.39
Maximum	33.8	Median	9.01
SD	8.286	CV	0.727
k hat (MLE)	2.083	k star (bias corrected MLE)	1.89
Theta hat (MLE)	5.47	Theta star (bias corrected MLE)	6.027
nu hat (MLE)	120.8	nu star (bias corrected)	109.6
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (109.63, α)	86.46	Adjusted Chi Square Value (109.63, β)	85.24
95% Gamma Approximate UCL (use when n>=50)	14.45	95% Gamma Adjusted UCL (use when n<50)	14.65

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	11.54	SD (KM)	8.057
Variance (KM)	64.92	SE of Mean (KM)	1.54
k hat (KM)	2.051	k star (KM)	1.862
nu hat (KM)	119	nu star (KM)	108
theta hat (KM)	5.626	theta star (KM)	6.197
80% gamma percentile (KM)	17.42	90% gamma percentile (KM)	22.83
95% gamma percentile (KM)	28	99% gamma percentile (KM)	39.53

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (108.00, α)	85.01	Adjusted Chi Square Value (108.00, β)	83.8
95% Gamma Approximate KM-UCL (use when n>=50)	14.66	95% Gamma Adjusted KM-UCL (use when n<50)	14.87

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.162	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.173	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	11.44	Mean in Log Scale	2.188
SD in Original Scale	8.236	SD in Log Scale	0.756
95% t UCL (assumes normality of ROS data)	14.05	95% Percentile Bootstrap UCL	14.01
95% BCA Bootstrap UCL	14.45	95% Bootstrap t UCL	14.68
95% H-UCL (Log ROS)	16.22		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.188	KM Geo Mean	8.915
KM SD (logged)	0.777	95% Critical H Value (KM-Log)	2.208
KM Standard Error of Mean (logged)	0.157	95% H-UCL (KM -Log)	16.67
KM SD (logged)	0.777	95% Critical H Value (KM-Log)	2.208
KM Standard Error of Mean (logged)	0.157		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	11.4	Mean in Log Scale	2.18
SD in Original Scale	8.271	SD in Log Scale	0.762
95% t UCL (Assumes normality)	14.01	95% H-Stat UCL	16.22

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	14.87	95% GROS Adjusted Gamma UCL	14.65

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	2.8	Mean	128.8
Maximum	760	Median	42.2
SD	201.8	Std. Error of Mean	37.46
Coefficient of Variation	1.567	Skewness	2.171

Normal GOF Test

Shapiro Wilk Test Statistic	0.639	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.287	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	192.5	95% Adjusted-CLT UCL (Chen-1995)	206.5
		95% Modified-t UCL (Johnson-1978)	195

Gamma GOF Test

A-D Test Statistic	0.822	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.804	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.133	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.171	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	0.57	k star (bias corrected MLE)	0.534
Theta hat (MLE)	225.9	Theta star (bias corrected MLE)	241.1
nu hat (MLE)	33.06	nu star (bias corrected)	30.97
MLE Mean (bias corrected)	128.8	MLE Sd (bias corrected)	176.2
		Approximate Chi Square Value (0.05)	19.26
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	18.71

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	207.1	95% Adjusted Gamma UCL (use when n<50)	213.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.926	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0777	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.161	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.03	Mean of logged Data	3.766
Maximum of Logged Data	6.633	SD of logged Data	1.598

Assuming Lognormal Distribution

95% H-UCL	418	90% Chebyshev (MVUE) UCL	301.9
95% Chebyshev (MVUE) UCL	374.6	97.5% Chebyshev (MVUE) UCL	475.6
99% Chebyshev (MVUE) UCL	673.8		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	190.4	95% Jackknife UCL	192.5
95% Standard Bootstrap UCL	191.1	95% Bootstrap-t UCL	223.3
95% Hall's Bootstrap UCL	201.2	95% Percentile Bootstrap UCL	190.7
95% BCA Bootstrap UCL	208.2		
90% Chebyshev(Mean, Sd) UCL	241.2	95% Chebyshev(Mean, Sd) UCL	292.1
97.5% Chebyshev(Mean, Sd) UCL	362.7	99% Chebyshev(Mean, Sd) UCL	501.5

Suggested UCL to Use

95% Adjusted Gamma UCL 213.2

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Iron (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	4290	Mean	21564
Maximum	74400	Median	15900
SD	16271	Std. Error of Mean	3021
Coefficient of Variation	0.755	Skewness	1.814

Normal GOF Test

Shapiro Wilk Test Statistic	0.802	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.26	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	26704	95% Adjusted-CLT UCL (Chen-1995)	27621
		95% Modified-t UCL (Johnson-1978)	26873

Gamma GOF Test

A-D Test Statistic	0.684	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.174	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.164	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.382	k star (bias corrected MLE)	2.159
Theta hat (MLE)	9052	Theta star (bias corrected MLE)	9989
nu hat (MLE)	138.2	nu star (bias corrected)	125.2
MLE Mean (bias corrected)	21564	MLE Sd (bias corrected)	14676
		Approximate Chi Square Value (0.05)	100.4
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	99.04

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	26901	95% Adjusted Gamma UCL (use when n<50)	27262

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.13	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.161	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.364	Mean of logged Data	9.754
Maximum of Logged Data	11.22	SD of logged Data	0.672

Assuming Lognormal Distribution

95% H-UCL	28195	90% Chebyshev (MVUE) UCL	30000
95% Chebyshev (MVUE) UCL	33899	97.5% Chebyshev (MVUE) UCL	39310
99% Chebyshev (MVUE) UCL	49939		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	26533	95% Jackknife UCL	26704
95% Standard Bootstrap UCL	26458	95% Bootstrap-t UCL	28389
95% Hall's Bootstrap UCL	28256	95% Percentile Bootstrap UCL	26643
95% BCA Bootstrap UCL	27691		
90% Chebyshev(Mean, Sd) UCL	30628	95% Chebyshev(Mean, Sd) UCL	34734
97.5% Chebyshev(Mean, Sd) UCL	40432	99% Chebyshev(Mean, Sd) UCL	51626

Suggested UCL to Use

95% Adjusted Gamma UCL 27262

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	15.2	Mean	4281
Maximum	40400	Median	298
SD	9353	Std. Error of Mean	1653
Coefficient of Variation	2.185	Skewness	2.815

Normal GOF Test

Shapiro Wilk Test Statistic	0.523	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.93	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.337	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.154	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7085	95% Adjusted-CLT UCL (Chen-1995)	7880
		95% Modified-t UCL (Johnson-1978)	7222

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	1.763	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.852	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.168	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.311	k star (bias corrected MLE)	0.303
Theta hat (MLE)	13754	Theta star (bias corrected MLE)	14133
nu hat (MLE)	19.92	nu star (bias corrected)	19.39
MLE Mean (bias corrected)	4281	MLE Sd (bias corrected)	7779
		Approximate Chi Square Value (0.05)	10.4
Adjusted Level of Significance	0.0416	Adjusted Chi Square Value	10.05

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7980	95% Adjusted Gamma UCL (use when n<50)	8261

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.154	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.721	Mean of logged Data	6.16
Maximum of Logged Data	10.61	SD of logged Data	2.294

Assuming Lognormal Distribution

95% H-UCL	38456	90% Chebyshev (MVUE) UCL	13794
95% Chebyshev (MVUE) UCL	17719	97.5% Chebyshev (MVUE) UCL	23168
99% Chebyshev (MVUE) UCL	33870		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7001	95% Jackknife UCL	7085
95% Standard Bootstrap UCL	6970	95% Bootstrap-t UCL	9510
95% Hall's Bootstrap UCL	7309	95% Percentile Bootstrap UCL	7218
95% BCA Bootstrap UCL	7934		
90% Chebyshev(Mean, Sd) UCL	9242	95% Chebyshev(Mean, Sd) UCL	11489
97.5% Chebyshev(Mean, Sd) UCL	14607	99% Chebyshev(Mean, Sd) UCL	20733

Suggested UCL to Use

97.5% Chebyshev (Mean, Sd) UCL 14607

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Manganese (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	57	Mean	475.8
Maximum	2080	Median	372
SD	437.8	Std. Error of Mean	81.31
Coefficient of Variation	0.92	Skewness	2.173

Normal GOF Test

Shapiro Wilk Test Statistic	0.788	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	614.1	95% Adjusted-CLT UCL (Chen-1995)	644.6
		95% Modified-t UCL (Johnson-1978)	619.6

Gamma GOF Test

A-D Test Statistic	0.211	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0934	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.165	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.566	k star (bias corrected MLE)	1.427
Theta hat (MLE)	303.7	Theta star (bias corrected MLE)	333.3
nu hat (MLE)	90.85	nu star (bias corrected)	82.78
MLE Mean (bias corrected)	475.8	MLE Sd (bias corrected)	398.2
		Approximate Chi Square Value (0.05)	62.81
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	61.78

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	627	95% Adjusted Gamma UCL (use when n<50)	637.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0651	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.161	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.043	Mean of logged Data	5.813
Maximum of Logged Data	7.64	SD of logged Data	0.881

Assuming Lognormal Distribution

95% H-UCL	725.8	90% Chebyshev (MVUE) UCL	750.3
95% Chebyshev (MVUE) UCL	870.7	97.5% Chebyshev (MVUE) UCL	1038
99% Chebyshev (MVUE) UCL	1366		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	609.5	95% Jackknife UCL	614.1
95% Standard Bootstrap UCL	607.1	95% Bootstrap-t UCL	675.9
95% Hall's Bootstrap UCL	697.4	95% Percentile Bootstrap UCL	618.7
95% BCA Bootstrap UCL	643.6		
90% Chebyshev(Mean, Sd) UCL	719.7	95% Chebyshev(Mean, Sd) UCL	830.2
97.5% Chebyshev(Mean, Sd) UCL	983.5	99% Chebyshev(Mean, Sd) UCL	1285

Suggested UCL to Use

95% Adjusted Gamma UCL 637.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	26
Number of Detects	20	Number of Non-Detects	9
Number of Distinct Detects	19	Number of Distinct Non-Detects	8
Minimum Detect	0.00595	Minimum Non-Detect	0.13
Maximum Detect	2.1	Maximum Non-Detect	0.22
Variance Detects	0.255	Percent Non-Detects	31.03%
Mean Detects	0.346	SD Detects	0.505
Median Detects	0.171	CV Detects	1.462
Skewness Detects	2.528	Kurtosis Detects	7.337
Mean of Logged Detects	-2.083	SD of Logged Detects	1.633

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.679	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.905	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.192	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.251	KM Standard Error of Mean	0.0827
KM SD	0.433	95% KM (BCA) UCL	0.407
95% KM (t) UCL	0.392	95% KM (Percentile Bootstrap) UCL	0.392
95% KM (z) UCL	0.387	95% KM Bootstrap t UCL	0.509
90% KM Chebyshev UCL	0.499	95% KM Chebyshev UCL	0.612
97.5% KM Chebyshev UCL	0.768	99% KM Chebyshev UCL	1.074

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.414	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.793	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.135	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.203	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.605	k star (bias corrected MLE)	0.548
Theta hat (MLE)	0.571	Theta star (bias corrected MLE)	0.631
nu hat (MLE)	24.2	nu star (bias corrected)	21.9
Mean (detects)	0.346		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00595	Mean	0.241
Maximum	2.1	Median	0.0272
SD	0.445	CV	1.844
k hat (MLE)	0.447	k star (bias corrected MLE)	0.424
Theta hat (MLE)	0.54	Theta star (bias corrected MLE)	0.569
nu hat (MLE)	25.95	nu star (bias corrected)	24.6
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (24.60, α)	14.31	Adjusted Chi Square Value (24.60, β)	13.84
95% Gamma Approximate UCL (use when n>=50)	0.415	95% Gamma Adjusted UCL (use when n<50)	0.429

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.251	SD (KM)	0.433
Variance (KM)	0.188	SE of Mean (KM)	0.0827
k hat (KM)	0.335	k star (KM)	0.323
nu hat (KM)	19.43	nu star (KM)	18.75
theta hat (KM)	0.749	theta star (KM)	0.776
80% gamma percentile (KM)	0.391	90% gamma percentile (KM)	0.733
95% gamma percentile (KM)	1.12	99% gamma percentile (KM)	2.117

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.75, α)	9.936	Adjusted Chi Square Value (18.75, β)	9.553
95% Gamma Approximate KM-UCL (use when n>=50)	0.473	95% Gamma Adjusted KM-UCL (use when n<50)	0.492

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.249	Mean in Log Scale	-2.503
SD in Original Scale	0.442	SD in Log Scale	1.498
95% t UCL (assumes normality of ROS data)	0.388	95% Percentile Bootstrap UCL	0.392
95% BCA Bootstrap UCL	0.456	95% Bootstrap t UCL	0.515
95% H-UCL (Log ROS)	0.612		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.557	KM Geo Mean	0.0775
KM SD (logged)	1.576	95% Critical H Value (KM-Log)	3.259
KM Standard Error of Mean (logged)	0.323	95% H-UCL (KM -Log)	0.708
KM SD (logged)	1.576	95% Critical H Value (KM-Log)	3.259
KM Standard Error of Mean (logged)	0.323		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.264	Mean in Log Scale	-2.212
SD in Original Scale	0.434	SD in Log Scale	1.362
95% t UCL (Assumes normality)	0.401	95% H-Stat UCL	0.591

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.492

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	28
Number of Detects	26	Number of Non-Detects	3
Number of Distinct Detects	25	Number of Distinct Non-Detects	3
Minimum Detect	2.9	Minimum Non-Detect	9.98
Maximum Detect	62.3	Maximum Non-Detect	14.6
Variance Detects	291.7	Percent Non-Detects	10.34%
Mean Detects	25.86	SD Detects	17.08
Median Detects	22.38	CV Detects	0.66
Skewness Detects	0.672	Kurtosis Detects	-0.371
Mean of Logged Detects	2.994	SD of Logged Detects	0.798

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.125	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.17	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	23.95	KM Standard Error of Mean	3.195
KM SD	16.85	95% KM (BCA) UCL	29.45
95% KM (t) UCL	29.39	95% KM (Percentile Bootstrap) UCL	29.38
95% KM (z) UCL	29.21	95% KM Bootstrap t UCL	29.81
90% KM Chebyshev UCL	33.54	95% KM Chebyshev UCL	37.88
97.5% KM Chebyshev UCL	43.91	99% KM Chebyshev UCL	55.75

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.264	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.105	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.173	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.085	k star (bias corrected MLE)	1.87
Theta hat (MLE)	12.4	Theta star (bias corrected MLE)	13.83
nu hat (MLE)	108.4	nu star (bias corrected)	97.25
Mean (detects)	25.86		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.9	Mean	24
Maximum	62.3	Median	19.3
SD	17.08	CV	0.712
k hat (MLE)	1.929	k star (bias corrected MLE)	1.752
Theta hat (MLE)	12.44	Theta star (bias corrected MLE)	13.69
nu hat (MLE)	111.9	nu star (bias corrected)	101.6
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (101.64, α)	79.38	Adjusted Chi Square Value (101.64, β)	78.21
95% Gamma Approximate UCL (use when n>=50)	30.73	95% Gamma Adjusted UCL (use when n<50)	31.19

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	23.95	SD (KM)	16.85
Variance (KM)	283.8	SE of Mean (KM)	3.195
k hat (KM)	2.022	k star (KM)	1.836
nu hat (KM)	117.3	nu star (KM)	106.5
theta hat (KM)	11.85	theta star (KM)	13.05
80% gamma percentile (KM)	36.22	90% gamma percentile (KM)	47.54
95% gamma percentile (KM)	58.39	99% gamma percentile (KM)	82.58

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (106.47, α)	83.66	Adjusted Chi Square Value (106.47, β)	82.45
95% Gamma Approximate KM-UCL (use when n>=50)	30.48	95% Gamma Adjusted KM-UCL (use when n<50)	30.93

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.124	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	24.01	Mean in Log Scale	2.899
SD in Original Scale	17.06	SD in Log Scale	0.807
95% t UCL (assumes normality of ROS data)	29.4	95% Percentile Bootstrap UCL	29.21
95% BCA Bootstrap UCL	29.47	95% Bootstrap t UCL	29.83
95% H-UCL (Log ROS)	35.37		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.884	KM Geo Mean	17.88
KM SD (logged)	0.82	95% Critical H Value (KM-Log)	2.255
KM Standard Error of Mean (logged)	0.158	95% H-UCL (KM -Log)	35.5
KM SD (logged)	0.82	95% Critical H Value (KM-Log)	2.255
KM Standard Error of Mean (logged)	0.158		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	23.83	Mean in Log Scale	2.872
SD in Original Scale	17.25	SD in Log Scale	0.84
95% t UCL (Assumes normality)	29.28	95% H-Stat UCL	36.09

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	29.39

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	27
Number of Detects	13	Number of Non-Detects	16
Number of Distinct Detects	13	Number of Distinct Non-Detects	14
Minimum Detect	2.8	Minimum Non-Detect	1.7
Maximum Detect	16.9	Maximum Non-Detect	10.5
Variance Detects	28.14	Percent Non-Detects	55.17%
Mean Detects	7.681	SD Detects	5.305
Median Detects	5.35	CV Detects	0.691
Skewness Detects	0.947	Kurtosis Detects	-0.785
Mean of Logged Detects	1.831	SD of Logged Detects	0.66

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.805	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.234	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.052	KM Standard Error of Mean	0.847
KM SD	4.24	95% KM (BCA) UCL	6.554
95% KM (t) UCL	6.492	95% KM (Percentile Bootstrap) UCL	6.478
95% KM (z) UCL	6.444	95% KM Bootstrap t UCL	6.825
90% KM Chebyshev UCL	7.591	95% KM Chebyshev UCL	8.742
97.5% KM Chebyshev UCL	10.34	99% KM Chebyshev UCL	13.47

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.716	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.193	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.239	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.563	k star (bias corrected MLE)	2.023
Theta hat (MLE)	2.996	Theta star (bias corrected MLE)	3.796
nu hat (MLE)	66.65	nu star (bias corrected)	52.6
Mean (detects)	7.681		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	4.388
Maximum	16.9	Median	2.8
SD	4.673	CV	1.065
k hat (MLE)	0.833	k star (bias corrected MLE)	0.77
Theta hat (MLE)	5.265	Theta star (bias corrected MLE)	5.698
nu hat (MLE)	48.33	nu star (bias corrected)	44.67
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (44.67, α)	30.34	Adjusted Chi Square Value (44.67, β)	29.63
95% Gamma Approximate UCL (use when n>=50)	6.461	95% Gamma Adjusted UCL (use when n<50)	6.615

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.052	SD (KM)	4.24
Variance (KM)	17.98	SE of Mean (KM)	0.847
k hat (KM)	1.419	k star (KM)	1.295
nu hat (KM)	82.32	nu star (KM)	75.14
theta hat (KM)	3.559	theta star (KM)	3.899
80% gamma percentile (KM)	7.938	90% gamma percentile (KM)	10.91
95% gamma percentile (KM)	13.83	99% gamma percentile (KM)	20.48

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (75.14, α)	56.17	Adjusted Chi Square Value (75.14, β)	55.19
95% Gamma Approximate KM-UCL (use when n>=50)	6.757	95% Gamma Adjusted KM-UCL (use when n<50)	6.877

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.911	Mean in Log Scale	1.337
SD in Original Scale	4.336	SD in Log Scale	0.668
95% t UCL (assumes normality of ROS data)	6.281	95% Percentile Bootstrap UCL	6.233
95% BCA Bootstrap UCL	6.709	95% Bootstrap t UCL	6.868
95% H-UCL (Log ROS)	6.203		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.37	KM Geo Mean	3.936
KM SD (logged)	0.66	95% Critical H Value (KM-Log)	2.089
KM Standard Error of Mean (logged)	0.148	95% H-UCL (KM -Log)	6.348
KM SD (logged)	0.66	95% Critical H Value (KM-Log)	2.089
KM Standard Error of Mean (logged)	0.148		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	4.94	Mean in Log Scale	1.331
SD in Original Scale	4.349	SD in Log Scale	0.702
95% t UCL (Assumes normality)	6.313	95% H-Stat UCL	6.424

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	6.877	95% GROS Adjusted Gamma UCL	6.615

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	16
Number of Detects	4	Number of Non-Detects	25
Number of Distinct Detects	4	Number of Distinct Non-Detects	13

Minimum Detect	0.33	Minimum Non-Detect	0.4
Maximum Detect	1.53	Maximum Non-Detect	3.8
Variance Detects	0.324	Percent Non-Detects	86.21%
Mean Detects	0.683	SD Detects	0.57
Median Detects	0.435	CV Detects	0.835
Skewness Detects	1.905	Kurtosis Detects	3.657
Mean of Logged Detects	-0.593	SD of Logged Detects	0.701

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.736	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.376	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.422	KM Standard Error of Mean	0.0686
KM SD	0.258	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.539	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.535	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.628	95% KM Chebyshev UCL	0.721
97.5% KM Chebyshev UCL	0.851	99% KM Chebyshev UCL	1.105

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.575	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.35	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.527	k star (bias corrected MLE)	0.798
Theta hat (MLE)	0.27	Theta star (bias corrected MLE)	0.855
nu hat (MLE)	20.22	nu star (bias corrected)	6.388
Mean (detects)	0.683		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0497	Mean	0.37
Maximum	1.53	Median	0.327
SD	0.263	CV	0.709
k hat (MLE)	2.953	k star (bias corrected MLE)	2.67
Theta hat (MLE)	0.125	Theta star (bias corrected MLE)	0.139
nu hat (MLE)	171.2	nu star (bias corrected)	154.9
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (154.87, α)	127.1	Adjusted Chi Square Value (154.87, β)	125.6
95% Gamma Approximate UCL (use when n>=50)	0.451	95% Gamma Adjusted UCL (use when n<50)	N/A

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.422	SD (KM)	0.258
Variance (KM)	0.0667	SE of Mean (KM)	0.0686
k hat (KM)	2.668	k star (KM)	2.415
nu hat (KM)	154.7	nu star (KM)	140.1
theta hat (KM)	0.158	theta star (KM)	0.175
80% gamma percentile (KM)	0.618	90% gamma percentile (KM)	0.786
95% gamma percentile (KM)	0.944	99% gamma percentile (KM)	1.292

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (140.07, α)	113.7	Adjusted Chi Square Value (140.07, β)	112.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.52	95% Gamma Adjusted KM-UCL (use when n<50)	0.526

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.828	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.307	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.41	Mean in Log Scale	-0.974
SD in Original Scale	0.233	SD in Log Scale	0.365
95% t UCL (assumes normality of ROS data)	0.484	95% Percentile Bootstrap UCL	0.487
95% BCA Bootstrap UCL	0.531	95% Bootstrap t UCL	0.578
95% H-UCL (Log ROS)	0.458		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.947	KM Geo Mean	0.388
KM SD (logged)	0.335	95% Critical H Value (KM-Log)	1.826
KM Standard Error of Mean (logged)	0.0969	95% H-UCL (KM -Log)	0.461
KM SD (logged)	0.335	95% Critical H Value (KM-Log)	1.826
KM Standard Error of Mean (logged)	0.0969		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.648	Mean in Log Scale	-0.658
SD in Original Scale	0.44	SD in Log Scale	0.698
95% t UCL (Assumes normality)	0.787	95% H-Stat UCL	0.875

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1) 0.526

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Thallium (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	22
Number of Detects	4	Number of Non-Detects	25
Number of Distinct Detects	4	Number of Distinct Non-Detects	18
Minimum Detect	0.4	Minimum Non-Detect	0.7
Maximum Detect	3.82	Maximum Non-Detect	7.5
Variance Detects	2.784	Percent Non-Detects	86.21%
Mean Detects	1.323	SD Detects	1.668
Median Detects	0.535	CV Detects	1.262
Skewness Detects	1.976	Kurtosis Detects	3.915
Mean of Logged Detects	-0.217	SD of Logged Detects	1.058

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.681	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.409	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.657	KM Standard Error of Mean	0.199
KM SD	0.733	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.995	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.984	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.254	95% KM Chebyshev UCL	1.525
97.5% KM Chebyshev UCL	1.901	99% KM Chebyshev UCL	2.639

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.69	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.665	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.392	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.402	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.146	k star (bias corrected MLE)	0.453
Theta hat (MLE)	1.154	Theta star (bias corrected MLE)	2.919
nu hat (MLE)	9.166	nu star (bias corrected)	3.625
Mean (detects)	1.323		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0361	Mean	0.625
Maximum	3.82	Median	0.462
SD	0.673	CV	1.076
k hat (MLE)	1.593	k star (bias corrected MLE)	1.451
Theta hat (MLE)	0.392	Theta star (bias corrected MLE)	0.43
nu hat (MLE)	92.41	nu star (bias corrected)	84.19
Adjusted Level of Significance (β)	0.0407		
Approximate Chi Square Value (84.19, α)	64.04	Adjusted Chi Square Value (84.19, β)	62.99
95% Gamma Approximate UCL (use when n>=50)	0.821	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.657	SD (KM)	0.733
Variance (KM)	0.538	SE of Mean (KM)	0.199
k hat (KM)	0.802	k star (KM)	0.742
nu hat (KM)	46.5	nu star (KM)	43.03
theta hat (KM)	0.819	theta star (KM)	0.885
80% gamma percentile (KM)	1.077	90% gamma percentile (KM)	1.625
95% gamma percentile (KM)	2.188	99% gamma percentile (KM)	3.525

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (43.03, α)	28.99	Adjusted Chi Square Value (43.03, β)	28.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.974	95% Gamma Adjusted KM-UCL (use when n<50)	0.998

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.779	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.336	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.656	Mean in Log Scale	-0.582
SD in Original Scale	0.628	SD in Log Scale	0.467
95% t UCL (assumes normality of ROS data)	0.855	95% Percentile Bootstrap UCL	0.89
95% BCA Bootstrap UCL	1.008	95% Bootstrap t UCL	1.32
95% H-UCL (Log ROS)	0.739		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.632	KM Geo Mean	0.532
KM SD (logged)	0.495	95% Critical H Value (KM-Log)	1.943
KM Standard Error of Mean (logged)	0.175	95% H-UCL (KM -Log)	0.721
KM SD (logged)	0.495	95% Critical H Value (KM-Log)	1.943
KM Standard Error of Mean (logged)	0.175		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.39	Mean in Log Scale	0.0352
SD in Original Scale	1.021	SD in Log Scale	0.808
95% t UCL (Assumes normality)	1.712	95% H-Stat UCL	2.023

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1) 0.998

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	29	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	5.2	Mean	24.68
Maximum	53.7	Median	22.6
SD	10.48	Std. Error of Mean	1.946
Coefficient of Variation	0.424	Skewness	0.875

Normal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	27.99	95% Adjusted-CLT UCL (Chen-1995)	28.22
		95% Modified-t UCL (Johnson-1978)	28.04

Gamma GOF Test

A-D Test Statistic	0.468	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.113	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.163	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.572	k star (bias corrected MLE)	5.018
Theta hat (MLE)	4.43	Theta star (bias corrected MLE)	4.918
nu hat (MLE)	323.1	nu star (bias corrected)	291.1
MLE Mean (bias corrected)	24.68	MLE Sd (bias corrected)	11.02
		Approximate Chi Square Value (0.05)	252.5
Adjusted Level of Significance	0.0407	Adjusted Chi Square Value	250.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	28.45	95% Adjusted Gamma UCL (use when n<50)	28.69

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.926	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.141	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.161	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.649	Mean of logged Data	3.114
Maximum of Logged Data	3.983	SD of logged Data	0.461

Assuming Lognormal Distribution

95% H-UCL	29.56	90% Chebyshev (MVUE) UCL	31.55
95% Chebyshev (MVUE) UCL	34.56	97.5% Chebyshev (MVUE) UCL	38.73
99% Chebyshev (MVUE) UCL	46.92		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	27.88	95% Jackknife UCL	27.99
95% Standard Bootstrap UCL	27.87	95% Bootstrap-t UCL	28.68
95% Hall's Bootstrap UCL	28.48	95% Percentile Bootstrap UCL	27.81
95% BCA Bootstrap UCL	28.09		
90% Chebyshev(Mean, Sd) UCL	30.52	95% Chebyshev(Mean, Sd) UCL	33.16
97.5% Chebyshev(Mean, Sd) UCL	36.83	99% Chebyshev(Mean, Sd) UCL	44.04

Suggested UCL to Use

95% Student's-t UCL 27.99

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	120	Mean	12556
Maximum	126000	Median	2685
SD	26620	Std. Error of Mean	4706
Coefficient of Variation	2.12	Skewness	3.174

Normal GOF Test

Shapiro Wilk Test Statistic	0.508	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.375	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	20534	95% Adjusted-CLT UCL (Chen-1995)	23117
		95% Modified-t UCL (Johnson-1978)	20974

Gamma GOF Test

A-D Test Statistic	1.826	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.822	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.165	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.45	k star (bias corrected MLE)	0.428
Theta hat (MLE)	27922	Theta star (bias corrected MLE)	29312
nu hat (MLE)	28.78	nu star (bias corrected)	27.41
MLE Mean (bias corrected)	12556	MLE Sd (bias corrected)	19184
		Approximate Chi Square Value (0.05)	16.47
Adjusted Level of Significance	0.0416	Adjusted Chi Square Value	16.02

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	20895	95% Adjusted Gamma UCL (use when n<50)	21489

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0779	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.154	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.787	Mean of logged Data	8.002
Maximum of Logged Data	11.74	SD of logged Data	1.706

Assuming Lognormal Distribution

95% H-UCL	36179	90% Chebyshev (MVUE) UCL	25351
95% Chebyshev (MVUE) UCL	31587	97.5% Chebyshev (MVUE) UCL	40241
99% Chebyshev (MVUE) UCL	57241		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	20296	95% Jackknife UCL	20534
95% Standard Bootstrap UCL	20203	95% Bootstrap-t UCL	28172
95% Hall's Bootstrap UCL	22470	95% Percentile Bootstrap UCL	21090
95% BCA Bootstrap UCL	24168		
90% Chebyshev(Mean, Sd) UCL	26673	95% Chebyshev(Mean, Sd) UCL	33068
97.5% Chebyshev(Mean, Sd) UCL	41943	99% Chebyshev(Mean, Sd) UCL	59377

Appendix D, Table 7. ProUCL Output - Elm Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 33068

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:28:26 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	71
		Number of Missing Observations	0
Minimum	121	Mean	3329
Maximum	16000	Median	2135
SD	3419	Std. Error of Mean	397.5
Coefficient of Variation	1.027	Skewness	1.506

Normal GOF Test

Shapiro Wilk Test Statistic	0.827	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	7.059E-12	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.174	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.103	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3991	95% Adjusted-CLT UCL (Chen-1995)	4057
		95% Modified-t UCL (Johnson-1978)	4003

Gamma GOF Test

A-D Test Statistic	0.679	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.783	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.104	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.107	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.949	k star (bias corrected MLE)	0.92
Theta hat (MLE)	3507	Theta star (bias corrected MLE)	3619
nu hat (MLE)	140.5	nu star (bias corrected)	136.1
MLE Mean (bias corrected)	3329	MLE Sd (bias corrected)	3471
		Approximate Chi Square Value (0.05)	110.2
Adjusted Level of Significance	0.0468	Adjusted Chi Square Value	109.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	4114	95% Adjusted Gamma UCL (use when n<50)	4131

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0151	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.109	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.103	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.796	Mean of logged Data	7.499
Maximum of Logged Data	9.68	SD of logged Data	1.231

Assuming Lognormal Distribution

95% H-UCL	5519	90% Chebyshev (MVUE) UCL	5850
95% Chebyshev (MVUE) UCL	6784	97.5% Chebyshev (MVUE) UCL	8082
99% Chebyshev (MVUE) UCL	10630		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3983	95% Jackknife UCL	3991
95% Standard Bootstrap UCL	3986	95% Bootstrap-t UCL	4090
95% Hall's Bootstrap UCL	4057	95% Percentile Bootstrap UCL	3989
95% BCA Bootstrap UCL	4065		
90% Chebyshev(Mean, Sd) UCL	4522	95% Chebyshev(Mean, Sd) UCL	5062
97.5% Chebyshev(Mean, Sd) UCL	5811	99% Chebyshev(Mean, Sd) UCL	7284

Suggested UCL to Use

95% Approximate Gamma UCL 4114

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	52
Number of Detects	15	Number of Non-Detects	47
Number of Distinct Detects	12	Number of Distinct Non-Detects	41
Minimum Detect	0.28	Minimum Non-Detect	1.1
Maximum Detect	2.5	Maximum Non-Detect	32.3
Variance Detects	0.459	Percent Non-Detects	75.81%
Mean Detects	1.078	SD Detects	0.677
Median Detects	0.96	CV Detects	0.628
Skewness Detects	0.873	Kurtosis Detects	-0.186
Mean of Logged Detects	-0.114	SD of Logged Detects	0.65

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.046	KM Standard Error of Mean	0.168
KM SD	0.647	95% KM (BCA) UCL	1.323
95% KM (t) UCL	1.327	95% KM (Percentile Bootstrap) UCL	1.328
95% KM (z) UCL	1.323	95% KM Bootstrap t UCL	1.395
90% KM Chebyshev UCL	1.55	95% KM Chebyshev UCL	1.779
97.5% KM Chebyshev UCL	2.096	99% KM Chebyshev UCL	2.718

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.355	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.224	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.795	k star (bias corrected MLE)	2.28
Theta hat (MLE)	0.386	Theta star (bias corrected MLE)	0.473
nu hat (MLE)	83.84	nu star (bias corrected)	68.41
Mean (detects)	1.078		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.28	Mean	0.966
Maximum	2.5	Median	0.93
SD	0.362	CV	0.375
k hat (MLE)	8.436	k star (bias corrected MLE)	8.039
Theta hat (MLE)	0.115	Theta star (bias corrected MLE)	0.12
nu hat (MLE)	1046	nu star (bias corrected)	996.8
Adjusted Level of Significance (β)	0.0461		
Approximate Chi Square Value (996.83, α)	924.5	Adjusted Chi Square Value (996.83, β)	922.9
95% Gamma Approximate UCL (use when n>=50)	1.042	95% Gamma Adjusted UCL (use when n<50)	1.043

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.046	SD (KM)	0.647
Variance (KM)	0.419	SE of Mean (KM)	0.168
k hat (KM)	2.614	k star (KM)	2.498
nu hat (KM)	324.1	nu star (KM)	309.7
theta hat (KM)	0.4	theta star (KM)	0.419
80% gamma percentile (KM)	1.526	90% gamma percentile (KM)	1.933
95% gamma percentile (KM)	2.317	99% gamma percentile (KM)	3.158

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (309.75, α)	270	Adjusted Chi Square Value (309.75, β)	269.1
95% Gamma Approximate KM-UCL (use when n>=50)	1.2	95% Gamma Adjusted KM-UCL (use when n<50)	1.204

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.163	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.918	Mean in Log Scale	-0.147
SD in Original Scale	0.362	SD in Log Scale	0.346
95% t UCL (assumes normality of ROS data)	0.995	95% Percentile Bootstrap UCL	0.999
95% BCA Bootstrap UCL	1.009	95% Bootstrap t UCL	1.017
95% H-UCL (Log ROS)	0.992		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.146	KM Geo Mean	0.864
KM SD (logged)	0.626	95% Critical H Value (KM-Log)	1.95
KM Standard Error of Mean (logged)	0.164	95% H-UCL (KM -Log)	1.229
KM SD (logged)	0.626	95% Critical H Value (KM-Log)	1.95
KM Standard Error of Mean (logged)	0.164		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.623	Mean in Log Scale	1.044
SD in Original Scale	2.331	SD in Log Scale	0.811
95% t UCL (Assumes normality)	4.117	95% H-Stat UCL	4.91

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 1.327

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	65
Number of Detects	72	Number of Non-Detects	2
Number of Distinct Detects	63	Number of Distinct Non-Detects	2

Minimum Detect	0.69	Minimum Non-Detect	2.43
Maximum Detect	46	Maximum Non-Detect	5.58
Variance Detects	64.62	Percent Non-Detects	2.703%
Mean Detects	9.646	SD Detects	8.039
Median Detects	8.14	CV Detects	0.833
Skewness Detects	2.516	Kurtosis Detects	8.064
Mean of Logged Detects	1.98	SD of Logged Detects	0.8

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.758	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	2.220E-16	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.195	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.104	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.441	KM Standard Error of Mean	0.933
KM SD	7.972	95% KM (BCA) UCL	11.02
95% KM (t) UCL	11	95% KM (Percentile Bootstrap) UCL	11.11
95% KM (z) UCL	10.98	95% KM Bootstrap t UCL	11.35
90% KM Chebyshev UCL	12.24	95% KM Chebyshev UCL	13.51
97.5% KM Chebyshev UCL	15.27	99% KM Chebyshev UCL	18.73

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.033	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.765	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.109	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.107	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.897	k star (bias corrected MLE)	1.827
Theta hat (MLE)	5.085	Theta star (bias corrected MLE)	5.279
nu hat (MLE)	273.2	nu star (bias corrected)	263.1
Mean (detects)	9.646		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0925	Mean	9.414
Maximum	46	Median	8.1
SD	8.052	CV	0.855
k hat (MLE)	1.627	k star (bias corrected MLE)	1.57
Theta hat (MLE)	5.787	Theta star (bias corrected MLE)	5.997
nu hat (MLE)	240.8	nu star (bias corrected)	232.3
Adjusted Level of Significance (β)	0.0468		
Approximate Chi Square Value (232.33, α)	198	Adjusted Chi Square Value (232.33, β)	197.4
95% Gamma Approximate UCL (use when n>=50)	11.04	95% Gamma Adjusted UCL (use when n<50)	11.08

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.441	SD (KM)	7.972
Variance (KM)	63.55	SE of Mean (KM)	0.933
k hat (KM)	1.402	k star (KM)	1.355
nu hat (KM)	207.6	nu star (KM)	200.5
theta hat (KM)	6.732	theta star (KM)	6.969
80% gamma percentile (KM)	14.77	90% gamma percentile (KM)	20.17
95% gamma percentile (KM)	25.45	99% gamma percentile (KM)	37.46

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (200.48, α)	168.7	Adjusted Chi Square Value (200.48, β)	168.1
95% Gamma Approximate KM-UCL (use when n>=50)	11.22	95% Gamma Adjusted KM-UCL (use when n<50)	11.26

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.957	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0444	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.128	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.104	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.448	Mean in Log Scale	1.949
SD in Original Scale	8.018	SD in Log Scale	0.813
95% t UCL (assumes normality of ROS data)	11	95% Percentile Bootstrap UCL	11.02
95% BCA Bootstrap UCL	11.3	95% Bootstrap t UCL	11.51
95% H-UCL (Log ROS)	11.92		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.942	KM Geo Mean	6.974
KM SD (logged)	0.822	95% Critical H Value (KM-Log)	2.093
KM Standard Error of Mean (logged)	0.0967	95% H-UCL (KM -Log)	11.96
KM SD (logged)	0.822	95% Critical H Value (KM-Log)	2.093
KM Standard Error of Mean (logged)	0.0967		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	9.439	Mean in Log Scale	1.943
SD in Original Scale	8.027	SD in Log Scale	0.823
95% t UCL (Assumes normality)	10.99	95% H-Stat UCL	11.99

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	13.51

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Barium (mg/kg)

General Statistics

Total Number of Observations	60	Number of Distinct Observations	52
Number of Detects	32	Number of Non-Detects	28
Number of Distinct Detects	30	Number of Distinct Non-Detects	24
Minimum Detect	26	Minimum Non-Detect	22.2
Maximum Detect	186	Maximum Non-Detect	54.5
Variance Detects	1801	Percent Non-Detects	46.67%
Mean Detects	79.16	SD Detects	42.44
Median Detects	72.1	CV Detects	0.536
Skewness Detects	0.659	Kurtosis Detects	-0.199
Mean of Logged Detects	4.223	SD of Logged Detects	0.569

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	52.88	KM Standard Error of Mean	5.45
KM SD	41.51	95% KM (BCA) UCL	62.86
95% KM (t) UCL	61.98	95% KM (Percentile Bootstrap) UCL	61.92
95% KM (z) UCL	61.84	95% KM Bootstrap t UCL	63.15
90% KM Chebyshev UCL	69.23	95% KM Chebyshev UCL	76.63
97.5% KM Chebyshev UCL	86.91	99% KM Chebyshev UCL	107.1

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.556	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.156	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.523	k star (bias corrected MLE)	3.214
Theta hat (MLE)	22.47	Theta star (bias corrected MLE)	24.63
nu hat (MLE)	225.5	nu star (bias corrected)	205.7
Mean (detects)	79.16		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	43.3
Maximum	186	Median	29.25
SD	49.47	CV	1.143
k hat (MLE)	0.272	k star (bias corrected MLE)	0.27
Theta hat (MLE)	159.1	Theta star (bias corrected MLE)	160.6
nu hat (MLE)	32.66	nu star (bias corrected)	32.36
Adjusted Level of Significance (β)	0.046		
Approximate Chi Square Value (32.36, α)	20.35	Adjusted Chi Square Value (32.36, β)	20.12
95% Gamma Approximate UCL (use when n>=50)	68.83	95% Gamma Adjusted UCL (use when n<50)	69.64

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	52.88	SD (KM)	41.51
Variance (KM)	1723	SE of Mean (KM)	5.45
k hat (KM)	1.622	k star (KM)	1.552
nu hat (KM)	194.7	nu star (KM)	186.3
theta hat (KM)	32.59	theta star (KM)	34.06
80% gamma percentile (KM)	81.5	90% gamma percentile (KM)	109.3
95% gamma percentile (KM)	136.2	99% gamma percentile (KM)	196.8

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (186.30, α)	155.7	Adjusted Chi Square Value (186.30, β)	155
95% Gamma Approximate KM-UCL (use when n>=50)	63.26	95% Gamma Adjusted KM-UCL (use when n<50)	63.54

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.148	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	50.61	Mean in Log Scale	3.594
SD in Original Scale	43.56	SD in Log Scale	0.802
95% t UCL (assumes normality of ROS data)	60.01	95% Percentile Bootstrap UCL	60.02
95% BCA Bootstrap UCL	61.59	95% Bootstrap t UCL	61.02
95% H-UCL (Log ROS)	62.71		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.71	KM Geo Mean	40.85
KM SD (logged)	0.687	95% Critical H Value (KM-Log)	2.032
KM Standard Error of Mean (logged)	0.0905	95% H-UCL (KM -Log)	62.02
KM SD (logged)	0.687	95% Critical H Value (KM-Log)	2.032
KM Standard Error of Mean (logged)	0.0905		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	48.81	Mean in Log Scale	3.475
SD in Original Scale	44.98	SD in Log Scale	0.918
95% t UCL (Assumes normality)	58.51	95% H-Stat UCL	64.43

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (t) UCL 61.98

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	56
Number of Detects	29	Number of Non-Detects	36
Number of Distinct Detects	24	Number of Distinct Non-Detects	34
Minimum Detect	0.031	Minimum Non-Detect	0.56
Maximum Detect	2.09	Maximum Non-Detect	2.69
Variance Detects	0.244	Percent Non-Detects	55.38%
Mean Detects	0.963	SD Detects	0.494
Median Detects	1	CV Detects	0.513
Skewness Detects	0.0441	Kurtosis Detects	0.421
Mean of Logged Detects	-0.291	SD of Logged Detects	0.934

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.144	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.601	KM Standard Error of Mean	0.0743
KM SD	0.49	95% KM (BCA) UCL	0.717
95% KM (t) UCL	0.725	95% KM (Percentile Bootstrap) UCL	0.733
95% KM (z) UCL	0.723	95% KM Bootstrap t UCL	0.728
90% KM Chebyshev UCL	0.824	95% KM Chebyshev UCL	0.924
97.5% KM Chebyshev UCL	1.065	99% KM Chebyshev UCL	1.34

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.9	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.247	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.165	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.124	k star (bias corrected MLE)	1.927
Theta hat (MLE)	0.453	Theta star (bias corrected MLE)	0.5
nu hat (MLE)	123.2	nu star (bias corrected)	111.8
Mean (detects)	0.963		

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.031	Mean	0.642
Maximum	2.09	Median	0.408
SD	0.438	CV	0.682
k hat (MLE)	2.402	k star (bias corrected MLE)	2.301
Theta hat (MLE)	0.268	Theta star (bias corrected MLE)	0.279
nu hat (MLE)	312.2	nu star (bias corrected)	299.1
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (299.13, α)	260.1	Adjusted Chi Square Value (299.13, β)	259.2
95% Gamma Approximate UCL (use when n>=50)	0.739	95% Gamma Adjusted UCL (use when n<50)	0.741

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.601	SD (KM)	0.49
Variance (KM)	0.24	SE of Mean (KM)	0.0743
k hat (KM)	1.504	k star (KM)	1.445
nu hat (KM)	195.6	nu star (KM)	187.9
theta hat (KM)	0.399	theta star (KM)	0.416
80% gamma percentile (KM)	0.933	90% gamma percentile (KM)	1.263
95% gamma percentile (KM)	1.585	99% gamma percentile (KM)	2.312

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (187.88, α)	157.2	Adjusted Chi Square Value (187.88, β)	156.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.718	95% Gamma Adjusted KM-UCL (use when n<50)	0.721

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.746	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.571	Mean in Log Scale	-0.892
SD in Original Scale	0.483	SD in Log Scale	0.831
95% t UCL (assumes normality of ROS data)	0.671	95% Percentile Bootstrap UCL	0.669
95% BCA Bootstrap UCL	0.686	95% Bootstrap t UCL	0.689
95% H-UCL (Log ROS)	0.722		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.994	KM Geo Mean	0.37
KM SD (logged)	1.155	95% Critical H Value (KM-Log)	2.248
KM Standard Error of Mean (logged)	0.263	95% H-UCL (KM -Log)	0.997
KM SD (logged)	1.155	95% Critical H Value (KM-Log)	2.248
KM Standard Error of Mean (logged)	0.263		

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.65	Mean in Log Scale	-0.672
SD in Original Scale	0.453	SD in Log Scale	0.743
95% t UCL (Assumes normality)	0.744	95% H-Stat UCL	0.813

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.725

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	101	Number of Distinct Observations	92
Number of Detects	99	Number of Non-Detects	2
Number of Distinct Detects	90	Number of Distinct Non-Detects	2
Minimum Detect	1	Minimum Non-Detect	0.628
Maximum Detect	237	Maximum Non-Detect	0.656
Variance Detects	3086	Percent Non-Detects	1.98%
Mean Detects	46.5	SD Detects	55.55
Median Detects	20	CV Detects	1.195
Skewness Detects	1.678	Kurtosis Detects	2.315
Mean of Logged Detects	3.117	SD of Logged Detects	1.28

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.751	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.245	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0893	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	45.59	KM Standard Error of Mean	5.51
KM SD	55.09	95% KM (BCA) UCL	54.77
95% KM (t) UCL	54.74	95% KM (Percentile Bootstrap) UCL	55.09
95% KM (z) UCL	54.65	95% KM Bootstrap t UCL	56.11
90% KM Chebyshev UCL	62.12	95% KM Chebyshev UCL	69.61
97.5% KM Chebyshev UCL	80	99% KM Chebyshev UCL	100.4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.05	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.792	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.139	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0932	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.818	k star (bias corrected MLE)	0.8
Theta hat (MLE)	56.81	Theta star (bias corrected MLE)	58.1
nu hat (MLE)	162.1	nu star (bias corrected)	158.5
Mean (detects)	46.5		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	45.58
Maximum	237	Median	19.8
SD	55.38	CV	1.215
k hat (MLE)	0.705	k star (bias corrected MLE)	0.691
Theta hat (MLE)	64.62	Theta star (bias corrected MLE)	65.96
nu hat (MLE)	142.5	nu star (bias corrected)	139.6
Adjusted Level of Significance (β)	0.0476		
Approximate Chi Square Value (139.59, α)	113.3	Adjusted Chi Square Value (139.59, β)	112.9
95% Gamma Approximate UCL (use when n>=50)	56.16	95% Gamma Adjusted UCL (use when n<50)	56.33

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	45.59	SD (KM)	55.09
Variance (KM)	3035	SE of Mean (KM)	5.51
k hat (KM)	0.685	k star (KM)	0.671
nu hat (KM)	138.3	nu star (KM)	135.6
theta hat (KM)	66.57	theta star (KM)	67.93
80% gamma percentile (KM)	75.03	90% gamma percentile (KM)	115.6
95% gamma percentile (KM)	157.6	99% gamma percentile (KM)	258.1

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (135.57, α)	109.7	Adjusted Chi Square Value (135.57, β)	109.3
95% Gamma Approximate KM-UCL (use when n>=50)	56.36	95% Gamma Adjusted KM-UCL (use when n<50)	56.53

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.961	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.029	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0776	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0893	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	45.6	Mean in Log Scale	3.052
SD in Original Scale	55.36	SD in Log Scale	1.348
95% t UCL (assumes normality of ROS data)	54.74	95% Percentile Bootstrap UCL	54.85
95% BCA Bootstrap UCL	55.63	95% Bootstrap t UCL	55.39
95% H-UCL (Log ROS)	73.92		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.046	KM Geo Mean	21.02
KM SD (logged)	1.356	95% Critical H Value (KM-Log)	2.557
KM Standard Error of Mean (logged)	0.136	95% H-UCL (KM -Log)	74.6
KM SD (logged)	1.356	95% Critical H Value (KM-Log)	2.557
KM Standard Error of Mean (logged)	0.136		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	45.59	Mean in Log Scale	3.032
SD in Original Scale	55.37	SD in Log Scale	1.4
95% t UCL (Assumes normality)	54.73	95% H-Stat UCL	79.63

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 74.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	65
Number of Detects	66	Number of Non-Detects	8
Number of Distinct Detects	57	Number of Distinct Non-Detects	8
Minimum Detect	0.77	Minimum Non-Detect	1.4
Maximum Detect	140	Maximum Non-Detect	4.92
Variance Detects	416.9	Percent Non-Detects	10.81%
Mean Detects	13.72	SD Detects	20.42
Median Detects	8.43	CV Detects	1.488
Skewness Detects	4.361	Kurtosis Detects	23.36
Mean of Logged Detects	2.077	SD of Logged Detects	0.997

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.55	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.263	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.109	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	12.42	KM Standard Error of Mean	2.284
KM SD	19.5	95% KM (BCA) UCL	16.19
95% KM (t) UCL	16.23	95% KM (Percentile Bootstrap) UCL	16.28
95% KM (z) UCL	16.18	95% KM Bootstrap t UCL	18.99
90% KM Chebyshev UCL	19.28	95% KM Chebyshev UCL	22.38
97.5% KM Chebyshev UCL	26.69	99% KM Chebyshev UCL	35.15

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.619	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.779	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.13	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.113	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.058	k star (bias corrected MLE)	1.02
Theta hat (MLE)	12.97	Theta star (bias corrected MLE)	13.46
nu hat (MLE)	139.6	nu star (bias corrected)	134.6
Mean (detects)	13.72		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	12.24
Maximum	140	Median	6.72
SD	19.74	CV	1.613
k hat (MLE)	0.545	k star (bias corrected MLE)	0.532
Theta hat (MLE)	22.46	Theta star (bias corrected MLE)	23.01
nu hat (MLE)	80.66	nu star (bias corrected)	78.72
Adjusted Level of Significance (β)	0.0468		
Approximate Chi Square Value (78.72, α)	59.28	Adjusted Chi Square Value (78.72, β)	58.95
95% Gamma Approximate UCL (use when n>=50)	16.25	95% Gamma Adjusted UCL (use when n<50)	16.35

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	12.42	SD (KM)	19.5
Variance (KM)	380.2	SE of Mean (KM)	2.284
k hat (KM)	0.406	k star (KM)	0.399
nu hat (KM)	60.09	nu star (KM)	58.98
theta hat (KM)	30.6	theta star (KM)	31.17
80% gamma percentile (KM)	20.04	90% gamma percentile (KM)	35.12
95% gamma percentile (KM)	51.69	99% gamma percentile (KM)	93.37

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (58.98, α)	42.32	Adjusted Chi Square Value (58.98, β)	42.04
95% Gamma Approximate KM-UCL (use when n>=50)	17.31	95% Gamma Adjusted KM-UCL (use when n<50)	17.43

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.985	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.839	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0524	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.109	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	12.42	Mean in Log Scale	1.898
SD in Original Scale	19.63	SD in Log Scale	1.084
95% t UCL (assumes normality of ROS data)	16.22	95% Percentile Bootstrap UCL	16.71
95% BCA Bootstrap UCL	18.04	95% Bootstrap t UCL	19.01
95% H-UCL (Log ROS)	16.16		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.892	KM Geo Mean	6.634
KM SD (logged)	1.092	95% Critical H Value (KM-Log)	2.348
KM Standard Error of Mean (logged)	0.129	95% H-UCL (KM -Log)	16.25
KM SD (logged)	1.092	95% Critical H Value (KM-Log)	2.348
KM Standard Error of Mean (logged)	0.129		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	12.4	Mean in Log Scale	1.885
SD in Original Scale	19.64	SD in Log Scale	1.104
95% t UCL (Assumes normality)	16.21	95% H-Stat UCL	16.44

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 16.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	54
Number of Detects	34	Number of Non-Detects	31
Number of Distinct Detects	30	Number of Distinct Non-Detects	25
Minimum Detect	6.3	Minimum Non-Detect	5.6
Maximum Detect	100	Maximum Non-Detect	10.8
Variance Detects	537.5	Percent Non-Detects	47.69%
Mean Detects	20.1	SD Detects	23.18
Median Detects	12.7	CV Detects	1.153
Skewness Detects	2.849	Kurtosis Detects	7.609
Mean of Logged Detects	2.669	SD of Logged Detects	0.715

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.558	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.933	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.15	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	13.26	KM Standard Error of Mean	2.268
KM SD	18.01	95% KM (BCA) UCL	17.28
95% KM (t) UCL	17.05	95% KM (Percentile Bootstrap) UCL	17.39
95% KM (z) UCL	16.99	95% KM Bootstrap t UCL	19.93
90% KM Chebyshev UCL	20.07	95% KM Chebyshev UCL	23.15
97.5% KM Chebyshev UCL	27.42	99% KM Chebyshev UCL	35.83

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.746	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.764	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.213	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.154	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.654	k star (bias corrected MLE)	1.528
Theta hat (MLE)	12.15	Theta star (bias corrected MLE)	13.16
nu hat (MLE)	112.5	nu star (bias corrected)	103.9
Mean (detects)	20.1		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	10.52
Maximum	100	Median	6.33
SD	19.48	CV	1.852
k hat (MLE)	0.229	k star (bias corrected MLE)	0.228
Theta hat (MLE)	46.04	Theta star (bias corrected MLE)	46.09
nu hat (MLE)	29.71	nu star (bias corrected)	29.67
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (29.67, α)	18.23	Adjusted Chi Square Value (29.67, β)	18.03
95% Gamma Approximate UCL (use when n>=50)	17.12	95% Gamma Adjusted UCL (use when n<50)	17.31

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	13.26	SD (KM)	18.01
Variance (KM)	324.4	SE of Mean (KM)	2.268
k hat (KM)	0.542	k star (KM)	0.527
nu hat (KM)	70.49	nu star (KM)	68.57
theta hat (KM)	24.46	theta star (KM)	25.14
80% gamma percentile (KM)	21.82	90% gamma percentile (KM)	35.48
95% gamma percentile (KM)	49.98	99% gamma percentile (KM)	85.47

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (68.57, α)	50.51	Adjusted Chi Square Value (68.57, β)	50.16
95% Gamma Approximate KM-UCL (use when n>=50)	18	95% Gamma Adjusted KM-UCL (use when n<50)	18.13

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.858	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.15	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	11.83	Mean in Log Scale	1.868
SD in Original Scale	18.8	SD in Log Scale	1.004
95% t UCL (assumes normality of ROS data)	15.73	95% Percentile Bootstrap UCL	15.84
95% BCA Bootstrap UCL	17.48	95% Bootstrap t UCL	18.75
95% H-UCL (Log ROS)	14.21		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.23	KM Geo Mean	9.295
KM SD (logged)	0.688	95% Critical H Value (KM-Log)	2.002
KM Standard Error of Mean (logged)	0.087	95% H-UCL (KM -Log)	14
KM SD (logged)	0.688	95% Critical H Value (KM-Log)	2.002
KM Standard Error of Mean (logged)	0.087		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	12.15	Mean in Log Scale	1.977
SD in Original Scale	18.65	SD in Log Scale	0.9
95% t UCL (Assumes normality)	16.01	95% H-Stat UCL	13.85

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 23.15

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	64
		Number of Missing Observations	0
Minimum	3.8	Mean	30.55
Maximum	314	Median	13.95
SD	45.02	Std. Error of Mean	5.233
Coefficient of Variation	1.473	Skewness	4.034

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.583	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.276	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.103	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	39.27	95% Adjusted-CLT UCL (Chen-1995)	41.78
		95% Modified-t UCL (Johnson-1978)	39.68

Gamma GOF Test

A-D Test Statistic	3.183	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.781	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.155	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.107	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.011	k star (bias corrected MLE)	0.979
Theta hat (MLE)	30.23	Theta star (bias corrected MLE)	31.21
nu hat (MLE)	149.6	nu star (bias corrected)	144.9
MLE Mean (bias corrected)	30.55	MLE Sd (bias corrected)	30.88
		Approximate Chi Square Value (0.05)	118.1
Adjusted Level of Significance	0.0468	Adjusted Chi Square Value	117.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	37.49	95% Adjusted Gamma UCL (use when n<50)	37.65

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00189	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.128	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.103	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.335	Mean of logged Data	2.849
Maximum of Logged Data	5.749	SD of logged Data	0.991

Assuming Lognormal Distribution

95% H-UCL	36.65	90% Chebyshev (MVUE) UCL	39.45
95% Chebyshev (MVUE) UCL	44.65	97.5% Chebyshev (MVUE) UCL	51.87
99% Chebyshev (MVUE) UCL	66.05		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	39.16	95% Jackknife UCL	39.27
95% Standard Bootstrap UCL	39.14	95% Bootstrap-t UCL	43.22
95% Hall's Bootstrap UCL	52.37	95% Percentile Bootstrap UCL	39.63
95% BCA Bootstrap UCL	42.07		
90% Chebyshev(Mean, Sd) UCL	46.25	95% Chebyshev(Mean, Sd) UCL	53.36
97.5% Chebyshev(Mean, Sd) UCL	63.23	99% Chebyshev(Mean, Sd) UCL	82.62

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 53.36

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	71
		Number of Missing Observations	0
Minimum	790	Mean	31362
Maximum	198000	Median	18400
SD	38514	Std. Error of Mean	4477
Coefficient of Variation	1.228	Skewness	2.408

Normal GOF Test

Shapiro Wilk Test Statistic	0.706	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.103	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	38821	95% Adjusted-CLT UCL (Chen-1995)	40065
		95% Modified-t UCL (Johnson-1978)	39029

Gamma GOF Test

A-D Test Statistic	0.927	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.784	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0998	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.107	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.947	k star (bias corrected MLE)	0.917
Theta hat (MLE)	33130	Theta star (bias corrected MLE)	34191
nu hat (MLE)	140.1	nu star (bias corrected)	135.8
MLE Mean (bias corrected)	31362	MLE Sd (bias corrected)	32746
		Approximate Chi Square Value (0.05)	109.8
Adjusted Level of Significance	0.0468	Adjusted Chi Square Value	109.4

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	38763	95% Adjusted Gamma UCL (use when n<50)	38926

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.978	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.526	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0959	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.103	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	6.672	Mean of logged Data	9.74
Maximum of Logged Data	12.2	SD of logged Data	1.175

Assuming Lognormal Distribution

95% H-UCL	47316	90% Chebyshev (MVUE) UCL	50416
95% Chebyshev (MVUE) UCL	58151	97.5% Chebyshev (MVUE) UCL	68887
99% Chebyshev (MVUE) UCL	89975		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	38726	95% Jackknife UCL	38821
95% Standard Bootstrap UCL	38658	95% Bootstrap-t UCL	41191
95% Hall's Bootstrap UCL	40806	95% Percentile Bootstrap UCL	39279
95% BCA Bootstrap UCL	40764		
90% Chebyshev(Mean, Sd) UCL	44793	95% Chebyshev(Mean, Sd) UCL	50877
97.5% Chebyshev(Mean, Sd) UCL	59321	99% Chebyshev(Mean, Sd) UCL	75909

Suggested UCL to Use

95% Approximate Gamma UCL 38763

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	101	Number of Distinct Observations	98
		Number of Missing Observations	0
Minimum	14.5	Mean	532.4
Maximum	4940	Median	248
SD	742.1	Std. Error of Mean	73.84
Coefficient of Variation	1.394	Skewness	3.036

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.669	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.245	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0884	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	655	95% Adjusted-CLT UCL (Chen-1995)	677.7
		95% Modified-t UCL (Johnson-1978)	658.7

Gamma GOF Test

A-D Test Statistic	1.669	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.793	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.133	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0925	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.796	k star (bias corrected MLE)	0.779
Theta hat (MLE)	668.8	Theta star (bias corrected MLE)	683.4
nu hat (MLE)	160.8	nu star (bias corrected)	157.4
MLE Mean (bias corrected)	532.4	MLE Sd (bias corrected)	603.2
		Approximate Chi Square Value (0.05)	129.4
Adjusted Level of Significance	0.0476	Adjusted Chi Square Value	129

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	647.6	95% Adjusted Gamma UCL (use when n<50)	649.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.188	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0675	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0884	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.674	Mean of logged Data	5.531
Maximum of Logged Data	8.505	SD of logged Data	1.291

Assuming Lognormal Distribution

95% H-UCL	801.8	90% Chebyshev (MVUE) UCL	861.3
95% Chebyshev (MVUE) UCL	991.9	97.5% Chebyshev (MVUE) UCL	1173
99% Chebyshev (MVUE) UCL	1530		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	653.9	95% Jackknife UCL	655
95% Standard Bootstrap UCL	654	95% Bootstrap-t UCL	692.7
95% Hall's Bootstrap UCL	692.2	95% Percentile Bootstrap UCL	652.3
95% BCA Bootstrap UCL	677.9		
90% Chebyshev(Mean, Sd) UCL	753.9	95% Chebyshev(Mean, Sd) UCL	854.3
97.5% Chebyshev(Mean, Sd) UCL	993.6	99% Chebyshev(Mean, Sd) UCL	1267

Suggested UCL to Use

95% H-UCL 801.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Manganese (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	69
		Number of Missing Observations	0
Minimum	9	Mean	464.5
Maximum	8900	Median	234
SD	1136	Std. Error of Mean	132
Coefficient of Variation	2.445	Skewness	6.229

Normal GOF Test

Shapiro Wilk Test Statistic	0.348	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.356	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.103	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	684.5	95% Adjusted-CLT UCL (Chen-1995)	783.9
		95% Modified-t UCL (Johnson-1978)	700.5

Gamma GOF Test

A-D Test Statistic	3.96	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.794	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.108	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	0.734	k star (bias corrected MLE)	0.713
Theta hat (MLE)	633.2	Theta star (bias corrected MLE)	651.6
nu hat (MLE)	108.6	nu star (bias corrected)	105.5
MLE Mean (bias corrected)	464.5	MLE Sd (bias corrected)	550.2
		Approximate Chi Square Value (0.05)	82.8
Adjusted Level of Significance	0.0468	Adjusted Chi Square Value	82.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	591.9	95% Adjusted Gamma UCL (use when n<50)	594.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.055	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.103	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.197	Mean of logged Data	5.323
Maximum of Logged Data	9.094	SD of logged Data	1.186

Assuming Lognormal Distribution

95% H-UCL	581.1	90% Chebyshev (MVUE) UCL	618.6
95% Chebyshev (MVUE) UCL	714.3	97.5% Chebyshev (MVUE) UCL	847.1
99% Chebyshev (MVUE) UCL	1108		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	681.7	95% Jackknife UCL	684.5
95% Standard Bootstrap UCL	682.5	95% Bootstrap-t UCL	1100
95% Hall's Bootstrap UCL	1393	95% Percentile Bootstrap UCL	709.1
95% BCA Bootstrap UCL	821.6		
90% Chebyshev(Mean, Sd) UCL	860.7	95% Chebyshev(Mean, Sd) UCL	1040
97.5% Chebyshev(Mean, Sd) UCL	1289	99% Chebyshev(Mean, Sd) UCL	1778

Suggested UCL to Use

95% H-UCL 581.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Mercury (mg/kg)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	48
Number of Detects	28	Number of Non-Detects	34
Number of Distinct Detects	28	Number of Distinct Non-Detects	23
Minimum Detect	0.032	Minimum Non-Detect	0.108
Maximum Detect	0.9	Maximum Non-Detect	0.567
Variance Detects	0.0616	Percent Non-Detects	54.84%
Mean Detects	0.313	SD Detects	0.248
Median Detects	0.27	CV Detects	0.793
Skewness Detects	0.843	Kurtosis Detects	-0.102
Mean of Logged Detects	-1.543	SD of Logged Detects	0.969

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.181	KM Standard Error of Mean	0.0272
KM SD	0.205	95% KM (BCA) UCL	0.227
95% KM (t) UCL	0.226	95% KM (Percentile Bootstrap) UCL	0.225
95% KM (z) UCL	0.225	95% KM Bootstrap t UCL	0.237
90% KM Chebyshev UCL	0.262	95% KM Chebyshev UCL	0.299
97.5% KM Chebyshev UCL	0.35	99% KM Chebyshev UCL	0.451

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.373	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.764	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0974	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.169	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.456	k star (bias corrected MLE)	1.323
Theta hat (MLE)	0.215	Theta star (bias corrected MLE)	0.236
nu hat (MLE)	81.51	nu star (bias corrected)	74.11
Mean (detects)	0.313		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.168
Maximum	0.9	Median	0.0783
SD	0.213	CV	1.267
k hat (MLE)	0.823	k star (bias corrected MLE)	0.794
Theta hat (MLE)	0.204	Theta star (bias corrected MLE)	0.212
nu hat (MLE)	102.1	nu star (bias corrected)	98.45
Adjusted Level of Significance (β)	0.0461		
Approximate Chi Square Value (98.45, α)	76.56	Adjusted Chi Square Value (98.45, β)	76.11
95% Gamma Approximate UCL (use when n>=50)	0.216	95% Gamma Adjusted UCL (use when n<50)	0.217

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.181	SD (KM)	0.205
Variance (KM)	0.0421	SE of Mean (KM)	0.0272
k hat (KM)	0.776	k star (KM)	0.749
nu hat (KM)	96.21	nu star (KM)	92.89
theta hat (KM)	0.233	theta star (KM)	0.241
80% gamma percentile (KM)	0.296	90% gamma percentile (KM)	0.446
95% gamma percentile (KM)	0.6	99% gamma percentile (KM)	0.965

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (92.89, α)	71.66	Adjusted Chi Square Value (92.89, β)	71.22
95% Gamma Approximate KM-UCL (use when n>=50)	0.234	95% Gamma Adjusted KM-UCL (use when n<50)	0.236

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.131	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.164	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.182	Mean in Log Scale	-2.143
SD in Original Scale	0.204	SD in Log Scale	0.876
95% t UCL (assumes normality of ROS data)	0.226	95% Percentile Bootstrap UCL	0.224
95% BCA Bootstrap UCL	0.232	95% Bootstrap t UCL	0.233
95% H-UCL (Log ROS)	0.219		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.198	KM Geo Mean	0.111
KM SD (logged)	0.931	95% Critical H Value (KM-Log)	2.204
KM Standard Error of Mean (logged)	0.146	95% H-UCL (KM -Log)	0.223
KM SD (logged)	0.931	95% Critical H Value (KM-Log)	2.204
KM Standard Error of Mean (logged)	0.146		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.184	Mean in Log Scale	-2.141
SD in Original Scale	0.205	SD in Log Scale	0.883
95% t UCL (Assumes normality)	0.228	95% H-Stat UCL	0.222

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.226

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/kg)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	10	Mean	40
Maximum	100	Median	10
SD	51.96	Std. Error of Mean	30
Coefficient of Variation	1.299	Skewness	1.732

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.75	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.385	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	127.6	95% Adjusted-CLT UCL (Chen-1995)	121.4
		95% Modified-t UCL (Johnson-1978)	132.6

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	0.94	k star (bias corrected MLE)	N/A
Theta hat (MLE)	42.56	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	5.639	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.75	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.385	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.303	Mean of logged Data	3.07
Maximum of Logged Data	4.605	SD of logged Data	1.329

Assuming Lognormal Distribution

95% H-UCL	6.430E+8	90% Chebyshev (MVUE) UCL	105.4
95% Chebyshev (MVUE) UCL	136.8	97.5% Chebyshev (MVUE) UCL	180.3
99% Chebyshev (MVUE) UCL	265.8		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	89.35	95% Jackknife UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	130	95% Chebyshev(Mean, Sd) UCL	170.8
97.5% Chebyshev(Mean, Sd) UCL	227.3	99% Chebyshev(Mean, Sd) UCL	338.5

Suggested UCL to Use

95% Student's-t UCL 127.6

Recommended UCL exceeds the maximum observation

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	74	Number of Distinct Observations	66
Number of Detects	64	Number of Non-Detects	10
Number of Distinct Detects	56	Number of Distinct Non-Detects	10
Minimum Detect	1.4	Minimum Non-Detect	4.96
Maximum Detect	199	Maximum Non-Detect	15.2
Variance Detects	1387	Percent Non-Detects	13.51%
Mean Detects	34.79	SD Detects	37.24
Median Detects	22.45	CV Detects	1.071
Skewness Detects	2.374	Kurtosis Detects	6.841
Mean of Logged Detects	3.064	SD of Logged Detects	1.047

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.75	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	2.087E-14	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	30.65	KM Standard Error of Mean	4.213
KM SD	35.94	95% KM (BCA) UCL	38.4
95% KM (t) UCL	37.67	95% KM (Percentile Bootstrap) UCL	37.96
95% KM (z) UCL	37.58	95% KM Bootstrap t UCL	39.36
90% KM Chebyshev UCL	43.29	95% KM Chebyshev UCL	49.01
97.5% KM Chebyshev UCL	56.96	99% KM Chebyshev UCL	72.57

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.685	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.776	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.109	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.114	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.168	k star (bias corrected MLE)	1.124
Theta hat (MLE)	29.79	Theta star (bias corrected MLE)	30.96
nu hat (MLE)	149.5	nu star (bias corrected)	143.8
Mean (detects)	34.79		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	30.12
Maximum	199	Median	15.95
SD	36.59	CV	1.215
k hat (MLE)	0.488	k star (bias corrected MLE)	0.478
Theta hat (MLE)	61.67	Theta star (bias corrected MLE)	63.06
nu hat (MLE)	72.28	nu star (bias corrected)	70.69
Adjusted Level of Significance (β)	0.0468		
Approximate Chi Square Value (70.69, α)	52.33	Adjusted Chi Square Value (70.69, β)	52.02
95% Gamma Approximate UCL (use when n>=50)	40.68	95% Gamma Adjusted UCL (use when n<50)	40.93

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	30.65	SD (KM)	35.94
Variance (KM)	1292	SE of Mean (KM)	4.213
k hat (KM)	0.727	k star (KM)	0.707
nu hat (KM)	107.6	nu star (KM)	104.6
theta hat (KM)	42.15	theta star (KM)	43.37
80% gamma percentile (KM)	50.36	90% gamma percentile (KM)	76.76
95% gamma percentile (KM)	104	99% gamma percentile (KM)	168.9

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (104.57, α)	81.97	Adjusted Chi Square Value (104.57, β)	81.58
95% Gamma Approximate KM-UCL (use when n>=50)	39.1	95% Gamma Adjusted KM-UCL (use when n<50)	39.29

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.974	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.419	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	30.68	Mean in Log Scale	2.841
SD in Original Scale	36.15	SD in Log Scale	1.132
95% t UCL (assumes normality of ROS data)	37.68	95% Percentile Bootstrap UCL	37.65
95% BCA Bootstrap UCL	38.76	95% Bootstrap t UCL	39.87
95% H-UCL (Log ROS)	44.66		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.809	KM Geo Mean	16.59
KM SD (logged)	1.189	95% Critical H Value (KM-Log)	2.449
KM Standard Error of Mean (logged)	0.143	95% H-UCL (KM -Log)	47.31
KM SD (logged)	1.189	95% Critical H Value (KM-Log)	2.449
KM Standard Error of Mean (logged)	0.143		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	30.64	Mean in Log Scale	2.828
SD in Original Scale	36.18	SD in Log Scale	1.152
95% t UCL (Assumes normality)	37.64	95% H-Stat UCL	45.47

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	39.1	95% GROS Approximate Gamma UCL	40.68

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	54
Number of Detects	10	Number of Non-Detects	55
Number of Distinct Detects	9	Number of Distinct Non-Detects	45

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	0.69	Minimum Non-Detect	3.9
Maximum Detect	14	Maximum Non-Detect	18.8
Variance Detects	28.45	Percent Non-Detects	84.62%
Mean Detects	5.816	SD Detects	5.334
Median Detects	2.7	CV Detects	0.917
Skewness Detects	0.574	Kurtosis Detects	-1.773
Mean of Logged Detects	1.259	SD of Logged Detects	1.13

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.81	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.314	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.446	KM Standard Error of Mean	0.471
KM SD	2.607	95% KM (BCA) UCL	3.188
95% KM (t) UCL	3.232	95% KM (Percentile Bootstrap) UCL	3.25
95% KM (z) UCL	3.22	95% KM Bootstrap t UCL	3.305
90% KM Chebyshev UCL	3.858	95% KM Chebyshev UCL	4.498
97.5% KM Chebyshev UCL	5.386	99% KM Chebyshev UCL	7.13

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.617	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.242	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.273	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.135	k star (bias corrected MLE)	0.861
Theta hat (MLE)	5.123	Theta star (bias corrected MLE)	6.752
nu hat (MLE)	22.71	nu star (bias corrected)	17.23
Mean (detects)	5.816		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.11	Mean	2.35
Maximum	14	Median	1.653
SD	2.577	CV	1.097
k hat (MLE)	1.854	k star (bias corrected MLE)	1.779
Theta hat (MLE)	1.268	Theta star (bias corrected MLE)	1.321
nu hat (MLE)	241	nu star (bias corrected)	231.2
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (231.25, α)	197	Adjusted Chi Square Value (231.25, β)	196.3
95% Gamma Approximate UCL (use when n>=50)	2.758	95% Gamma Adjusted UCL (use when n<50)	2.768

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.446	SD (KM)	2.607
Variance (KM)	6.795	SE of Mean (KM)	0.471
k hat (KM)	0.88	k star (KM)	0.85
nu hat (KM)	114.5	nu star (KM)	110.5
theta hat (KM)	2.778	theta star (KM)	2.877
80% gamma percentile (KM)	3.983	90% gamma percentile (KM)	5.861
95% gamma percentile (KM)	7.763	99% gamma percentile (KM)	12.24

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (110.51, α)	87.24	Adjusted Chi Square Value (110.51, β)	86.78
95% Gamma Approximate KM-UCL (use when n>=50)	3.098	95% Gamma Adjusted KM-UCL (use when n<50)	3.115

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.205	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.357	Mean in Log Scale	0.631
SD in Original Scale	2.526	SD in Log Scale	0.553
95% t UCL (assumes normality of ROS data)	2.88	95% Percentile Bootstrap UCL	2.887
95% BCA Bootstrap UCL	3.087	95% Bootstrap t UCL	3.234
95% H-UCL (Log ROS)	2.497		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.586	KM Geo Mean	1.797
KM SD (logged)	0.721	95% Critical H Value (KM-Log)	2.028
KM Standard Error of Mean (logged)	0.23	95% H-UCL (KM -Log)	2.798
KM SD (logged)	0.721	95% Critical H Value (KM-Log)	2.028
KM Standard Error of Mean (logged)	0.23		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.187	Mean in Log Scale	0.986
SD in Original Scale	2.588	SD in Log Scale	0.521
95% t UCL (Assumes normality)	3.723	95% H-Stat UCL	3.47

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	3.098

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Silver (mg/kg)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	41
Number of Detects	6	Number of Non-Detects	59
Number of Distinct Detects	5	Number of Distinct Non-Detects	37
Minimum Detect	0.26	Minimum Non-Detect	0.7
Maximum Detect	8	Maximum Non-Detect	5.38
Variance Detects	11.7	Percent Non-Detects	90.77%
Mean Detects	3.708	SD Detects	3.42
Median Detects	2.345	CV Detects	0.922
Skewness Detects	0.728	Kurtosis Detects	-1.834
Mean of Logged Detects	0.793	SD of Logged Detects	1.282

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.818	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.284	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.601	KM Standard Error of Mean	0.19
KM SD	1.383	95% KM (BCA) UCL	1.523
95% KM (t) UCL	0.918	95% KM (Percentile Bootstrap) UCL	1.385
95% KM (z) UCL	0.914	95% KM Bootstrap t UCL	1.078
90% KM Chebyshev UCL	1.171	95% KM Chebyshev UCL	1.429
97.5% KM Chebyshev UCL	1.788	99% KM Chebyshev UCL	2.492

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.319	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.714	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.223	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.34	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.102	k star (bias corrected MLE)	0.662
Theta hat (MLE)	3.364	Theta star (bias corrected MLE)	5.599
nu hat (MLE)	13.23	nu star (bias corrected)	7.948
Mean (detects)	3.708		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.373
Maximum	8	Median	0.01
SD	1.44	CV	3.857
k hat (MLE)	0.243	k star (bias corrected MLE)	0.242
Theta hat (MLE)	1.539	Theta star (bias corrected MLE)	1.545
nu hat (MLE)	31.53	nu star (bias corrected)	31.41
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (31.41, α)	19.6	Adjusted Chi Square Value (31.41, β)	19.39
95% Gamma Approximate UCL (use when n>=50)	0.598	95% Gamma Adjusted UCL (use when n<50)	0.605

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.601	SD (KM)	1.383
Variance (KM)	1.912	SE of Mean (KM)	0.19
k hat (KM)	0.189	k star (KM)	0.19
nu hat (KM)	24.55	nu star (KM)	24.75
theta hat (KM)	3.182	theta star (KM)	3.156
80% gamma percentile (KM)	0.771	90% gamma percentile (KM)	1.816
95% gamma percentile (KM)	3.135	99% gamma percentile (KM)	6.798

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (24.75, α)	14.42	Adjusted Chi Square Value (24.75, β)	14.24
95% Gamma Approximate KM-UCL (use when n>=50)	1.031	95% Gamma Adjusted KM-UCL (use when n<50)	1.044

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.913	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.176	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.572	Mean in Log Scale	-1.313
SD in Original Scale	1.396	SD in Log Scale	0.939
95% t UCL (assumes normality of ROS data)	0.861	95% Percentile Bootstrap UCL	0.867
95% BCA Bootstrap UCL	1.024	95% Bootstrap t UCL	1.528
95% H-UCL (Log ROS)	0.542		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.118	KM Geo Mean	0.327
KM SD (logged)	0.743	95% Critical H Value (KM-Log)	2.046
KM Standard Error of Mean (logged)	0.109	95% H-UCL (KM -Log)	0.521
KM SD (logged)	0.743	95% Critical H Value (KM-Log)	2.046
KM Standard Error of Mean (logged)	0.109		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.071	Mean in Log Scale	-0.197
SD in Original Scale	1.337	SD in Log Scale	0.589
95% t UCL (Assumes normality)	1.348	95% H-Stat UCL	1.125

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (t) UCL 0.918

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium (mg/kg)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	46
Number of Detects	1	Number of Non-Detects	61
Number of Distinct Detects	1	Number of Distinct Non-Detects	45

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Thallium (mg/kg) was not processed!

Vanadium (mg/kg)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	55
Number of Detects	37	Number of Non-Detects	25
Number of Distinct Detects	33	Number of Distinct Non-Detects	22
Minimum Detect	7.33	Minimum Non-Detect	5.6
Maximum Detect	55.5	Maximum Non-Detect	26.9
Variance Detects	134.1	Percent Non-Detects	40.32%
Mean Detects	20.75	SD Detects	11.58
Median Detects	17.6	CV Detects	0.558
Skewness Detects	1.555	Kurtosis Detects	2.383
Mean of Logged Detects	2.904	SD of Logged Detects	0.504

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.936	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.199	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.144	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	14.82	KM Standard Error of Mean	1.484
KM SD	11.48	95% KM (BCA) UCL	17.43
95% KM (t) UCL	17.3	95% KM (Percentile Bootstrap) UCL	17.32
95% KM (z) UCL	17.26	95% KM Bootstrap t UCL	17.76
90% KM Chebyshev UCL	19.27	95% KM Chebyshev UCL	21.29
97.5% KM Chebyshev UCL	24.09	99% KM Chebyshev UCL	29.59

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.582	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.145	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.146	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.052	k star (bias corrected MLE)	3.741
Theta hat (MLE)	5.12	Theta star (bias corrected MLE)	5.545
nu hat (MLE)	299.8	nu star (bias corrected)	276.9
Mean (detects)	20.75		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	12.84
Maximum	55.5	Median	11.9
SD	13.23	CV	1.031
k hat (MLE)	0.49	k star (bias corrected MLE)	0.477
Theta hat (MLE)	26.21	Theta star (bias corrected MLE)	26.92
nu hat (MLE)	60.73	nu star (bias corrected)	59.13
Adjusted Level of Significance (β)	0.0461		
Approximate Chi Square Value (59.13, α)	42.45	Adjusted Chi Square Value (59.13, β)	42.11
95% Gamma Approximate UCL (use when n>=50)	17.88	95% Gamma Adjusted UCL (use when n<50)	18.02

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	14.82	SD (KM)	11.48
Variance (KM)	131.8	SE of Mean (KM)	1.484
k hat (KM)	1.666	k star (KM)	1.596
nu hat (KM)	206.5	nu star (KM)	197.9
theta hat (KM)	8.895	theta star (KM)	9.284
80% gamma percentile (KM)	22.77	90% gamma percentile (KM)	30.41
95% gamma percentile (KM)	37.81	99% gamma percentile (KM)	54.44

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (197.89, α)	166.3	Adjusted Chi Square Value (197.89, β)	165.7
95% Gamma Approximate KM-UCL (use when n>=50)	17.63	95% Gamma Adjusted KM-UCL (use when n<50)	17.7

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.111	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.144	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	14.82	Mean in Log Scale	2.452
SD in Original Scale	11.51	SD in Log Scale	0.684
95% t UCL (assumes normality of ROS data)	17.26	95% Percentile Bootstrap UCL	17.21
95% BCA Bootstrap UCL	17.61	95% Bootstrap t UCL	17.64
95% H-UCL (Log ROS)	17.48		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.446	KM Geo Mean	11.54
KM SD (logged)	0.689	95% Critical H Value (KM-Log)	1.998
KM Standard Error of Mean (logged)	0.0896	95% H-UCL (KM -Log)	17.45
KM SD (logged)	0.689	95% Critical H Value (KM-Log)	1.998
KM Standard Error of Mean (logged)	0.0896		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	13.99	Mean in Log Scale	2.249
SD in Original Scale	12.26	SD in Log Scale	0.925
95% t UCL (Assumes normality)	16.6	95% H-Stat UCL	18.87

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	17.63	95% GROS Approximate Gamma UCL	17.88

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	101	Number of Distinct Observations	99
		Number of Missing Observations	0
Minimum	75.2	Mean	8152
Maximum	43000	Median	4780
SD	9666	Std. Error of Mean	961.8
Coefficient of Variation	1.186	Skewness	1.956

Normal GOF Test

Shapiro Wilk Test Statistic	0.736	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.247	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0884	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	9749	95% Adjusted-CLT UCL (Chen-1995)	9934
		95% Modified-t UCL (Johnson-1978)	9780

Gamma GOF Test

A-D Test Statistic	0.864	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.793	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0998	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0925	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.798	k star (bias corrected MLE)	0.781
Theta hat (MLE)	10219	Theta star (bias corrected MLE)	10443
nu hat (MLE)	161.1	nu star (bias corrected)	157.7
MLE Mean (bias corrected)	8152	MLE Sd (bias corrected)	9227
		Approximate Chi Square Value (0.05)	129.7
Adjusted Level of Significance	0.0476	Adjusted Chi Square Value	129.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	9914	95% Adjusted Gamma UCL (use when n<50)	9942

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	9.2166E-7	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.129	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0884	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.32	Mean of logged Data	8.262
Maximum of Logged Data	10.67	SD of logged Data	1.456

Assuming Lognormal Distribution

95% H-UCL	16477	90% Chebyshev (MVUE) UCL	17464
95% Chebyshev (MVUE) UCL	20416	97.5% Chebyshev (MVUE) UCL	24513
99% Chebyshev (MVUE) UCL	32562		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	9734	95% Jackknife UCL	9749
95% Standard Bootstrap UCL	9674	95% Bootstrap-t UCL	10110
95% Hall's Bootstrap UCL	9935	95% Percentile Bootstrap UCL	9800
95% BCA Bootstrap UCL	9929		
90% Chebyshev(Mean, Sd) UCL	11038	95% Chebyshev(Mean, Sd) UCL	12345
97.5% Chebyshev(Mean, Sd) UCL	14159	99% Chebyshev(Mean, Sd) UCL	17722

Appendix D, Table 8. ProUCL Output - Tar Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 12345

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:23:08 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	3920	Mean	13049
Maximum	28000	Median	10470
SD	7853	Std. Error of Mean	1963
Coefficient of Variation	0.602	Skewness	0.833

Normal GOF Test

Shapiro Wilk Test Statistic	0.892	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.186	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	16490	95% Adjusted-CLT UCL (Chen-1995)	16715
		95% Modified-t UCL (Johnson-1978)	16559

Gamma GOF Test

A-D Test Statistic	0.327	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.146	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.217	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.071	k star (bias corrected MLE)	2.536
Theta hat (MLE)	4250	Theta star (bias corrected MLE)	5144
nu hat (MLE)	98.26	nu star (bias corrected)	81.17
MLE Mean (bias corrected)	13049	MLE Sd (bias corrected)	8193
		Approximate Chi Square Value (0.05)	61.41
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	59.45

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	17248	95% Adjusted Gamma UCL (use when n<50)	17815

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.274	Mean of logged Data	9.305
Maximum of Logged Data	10.24	SD of logged Data	0.612

Assuming Lognormal Distribution

95% H-UCL	18693	90% Chebyshev (MVUE) UCL	19357
95% Chebyshev (MVUE) UCL	22200	97.5% Chebyshev (MVUE) UCL	26147
99% Chebyshev (MVUE) UCL	33899		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	16278	95% Jackknife UCL	16490
95% Standard Bootstrap UCL	16269	95% Bootstrap-t UCL	17130
95% Hall's Bootstrap UCL	16868	95% Percentile Bootstrap UCL	16213
95% BCA Bootstrap UCL	16421		
90% Chebyshev(Mean, Sd) UCL	18939	95% Chebyshev(Mean, Sd) UCL	21606
97.5% Chebyshev(Mean, Sd) UCL	25309	99% Chebyshev(Mean, Sd) UCL	32583

Suggested UCL to Use

95% Student's-t UCL 16490

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	9
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	3.14	Minimum Non-Detect	10
Maximum Detect	13	Maximum Non-Detect	10
Variance Detects	14.38	Percent Non-Detects	25%
Mean Detects	8.108	SD Detects	3.792
Median Detects	9.31	CV Detects	0.468
Skewness Detects	-0.113	Kurtosis Detects	-1.692
Mean of Logged Detects	1.97	SD of Logged Detects	0.544

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.88	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.302	KM Standard Error of Mean	0.987
KM SD	3.571	95% KM (BCA) UCL	8.808
95% KM (t) UCL	9.032	95% KM (Percentile Bootstrap) UCL	8.874
95% KM (z) UCL	8.925	95% KM Bootstrap t UCL	9.109
90% KM Chebyshev UCL	10.26	95% KM Chebyshev UCL	11.6
97.5% KM Chebyshev UCL	13.47	99% KM Chebyshev UCL	17.12

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.73	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.735	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.228	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.23	k star (bias corrected MLE)	3.228
Theta hat (MLE)	1.917	Theta star (bias corrected MLE)	2.512
nu hat (MLE)	101.5	nu star (bias corrected)	77.47
Mean (detects)	8.108		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3.14	Mean	7.354
Maximum	13	Median	6.465
SD	3.582	CV	0.487
k hat (MLE)	4.333	k star (bias corrected MLE)	3.563
Theta hat (MLE)	1.697	Theta star (bias corrected MLE)	2.064
nu hat (MLE)	138.7	nu star (bias corrected)	114
Adjusted Level of Significance (β)	0.0335		
Approximate Chi Square Value (114.00, α)	90.35	Adjusted Chi Square Value (114.00, β)	87.96
95% Gamma Approximate UCL (use when n>=50)	9.279	95% Gamma Adjusted UCL (use when n<50)	9.532

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.302	SD (KM)	3.571
Variance (KM)	12.75	SE of Mean (KM)	0.987
k hat (KM)	4.181	k star (KM)	3.438
nu hat (KM)	133.8	nu star (KM)	110
theta hat (KM)	1.747	theta star (KM)	2.124
80% gamma percentile (KM)	10.25	90% gamma percentile (KM)	12.58
95% gamma percentile (KM)	14.75	99% gamma percentile (KM)	19.4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (110.03, α)	86.82	Adjusted Chi Square Value (110.03, β)	84.47
95% Gamma Approximate KM-UCL (use when n>=50)	9.254	95% Gamma Adjusted KM-UCL (use when n<50)	9.511

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.229	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.288	Mean in Log Scale	1.864
SD in Original Scale	3.612	SD in Log Scale	0.519
95% t UCL (assumes normality of ROS data)	8.871	95% Percentile Bootstrap UCL	8.709
95% BCA Bootstrap UCL	8.707	95% Bootstrap t UCL	9.05
95% H-UCL (Log ROS)	9.737		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.857	KM Geo Mean	6.407
KM SD (logged)	0.522	95% Critical H Value (KM-Log)	2.073
KM Standard Error of Mean (logged)	0.148	95% H-UCL (KM -Log)	9.706
KM SD (logged)	0.522	95% Critical H Value (KM-Log)	2.073
KM Standard Error of Mean (logged)	0.148		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	7.331	Mean in Log Scale	1.88
SD in Original Scale	3.532	SD in Log Scale	0.493
95% t UCL (Assumes normality)	8.879	95% H-Stat UCL	9.598

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 9.032

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	58.4	Mean	104.1
Maximum	177	Median	101
SD	34.61	Std. Error of Mean	10.94
Coefficient of Variation	0.332	Skewness	0.824

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	124.2	95% Adjusted-CLT UCL (Chen-1995)	125.1
		95% Modified-t UCL (Johnson-1978)	124.6

Gamma GOF Test

A-D Test Statistic	0.161	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.725	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.106	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.267	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.46	k star (bias corrected MLE)	7.387
Theta hat (MLE)	9.953	Theta star (bias corrected MLE)	14.09
nu hat (MLE)	209.2	nu star (bias corrected)	147.7
MLE Mean (bias corrected)	104.1	MLE Sd (bias corrected)	38.3
		Approximate Chi Square Value (0.05)	120.7
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	116.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	127.5	95% Adjusted Gamma UCL (use when n<50)	132.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.112	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.067	Mean of logged Data	4.597
Maximum of Logged Data	5.176	SD of logged Data	0.329

Assuming Lognormal Distribution

95% H-UCL	130.4	90% Chebyshev (MVUE) UCL	136.8
95% Chebyshev (MVUE) UCL	151.7	97.5% Chebyshev (MVUE) UCL	172.3
99% Chebyshev (MVUE) UCL	212.7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	122.1	95% Jackknife UCL	124.2
95% Standard Bootstrap UCL	121.2	95% Bootstrap-t UCL	128.7
95% Hall's Bootstrap UCL	131	95% Percentile Bootstrap UCL	122.2
95% BCA Bootstrap UCL	124		
90% Chebyshev(Mean, Sd) UCL	136.9	95% Chebyshev(Mean, Sd) UCL	151.8
97.5% Chebyshev(Mean, Sd) UCL	172.4	99% Chebyshev(Mean, Sd) UCL	213

Suggested UCL to Use

95% Student's-t UCL 124.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Number of Detects	5	Number of Non-Detects	3
Number of Distinct Detects	5	Number of Distinct Non-Detects	3
Minimum Detect	0.5	Minimum Non-Detect	0.703
Maximum Detect	2	Maximum Non-Detect	0.919
Variance Detects	0.31	Percent Non-Detects	37.5%
Mean Detects	1.07	SD Detects	0.556
Median Detects	0.949	CV Detects	0.52
Skewness Detects	1.483	Kurtosis Detects	3.155
Mean of Logged Detects	-0.0315	SD of Logged Detects	0.492

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.35	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.869	KM Standard Error of Mean	0.19
KM SD	0.476	95% KM (BCA) UCL	1.262
95% KM (t) UCL	1.229	95% KM (Percentile Bootstrap) UCL	1.206
95% KM (z) UCL	1.181	95% KM Bootstrap t UCL	1.321
90% KM Chebyshev UCL	1.439	95% KM Chebyshev UCL	1.698
97.5% KM Chebyshev UCL	2.056	99% KM Chebyshev UCL	2.761

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.422	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.681	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.302	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.211	k star (bias corrected MLE)	2.218
Theta hat (MLE)	0.205	Theta star (bias corrected MLE)	0.482
nu hat (MLE)	52.11	nu star (bias corrected)	22.18
Mean (detects)	1.07		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.385	Mean	0.827
Maximum	2	Median	0.7
SD	0.539	CV	0.651
k hat (MLE)	3.37	k star (bias corrected MLE)	2.19
Theta hat (MLE)	0.245	Theta star (bias corrected MLE)	0.378
nu hat (MLE)	53.93	nu star (bias corrected)	35.04
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (35.04, α)	22.49	Adjusted Chi Square Value (35.04, β)	19.99
95% Gamma Approximate UCL (use when n>=50)	1.288	95% Gamma Adjusted UCL (use when n<50)	1.45

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.869	SD (KM)	0.476
Variance (KM)	0.227	SE of Mean (KM)	0.19
k hat (KM)	3.327	k star (KM)	2.162
nu hat (KM)	53.22	nu star (KM)	34.6
theta hat (KM)	0.261	theta star (KM)	0.402
80% gamma percentile (KM)	1.288	90% gamma percentile (KM)	1.659
95% gamma percentile (KM)	2.01	99% gamma percentile (KM)	2.787

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (34.60, α)	22.14	Adjusted Chi Square Value (34.60, β)	19.66
95% Gamma Approximate KM-UCL (use when n>=50)	1.357	95% Gamma Adjusted KM-UCL (use when n<50)	1.529

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.924	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.274	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.861	Mean in Log Scale	-0.27
SD in Original Scale	0.51	SD in Log Scale	0.499
95% t UCL (assumes normality of ROS data)	1.203	95% Percentile Bootstrap UCL	1.172
95% BCA Bootstrap UCL	1.246	95% Bootstrap t UCL	1.457
95% H-UCL (Log ROS)	1.347		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.261	KM Geo Mean	0.77
KM SD (logged)	0.468	95% Critical H Value (KM-Log)	2.301
KM Standard Error of Mean (logged)	0.189	95% H-UCL (KM -Log)	1.291
KM SD (logged)	0.468	95% Critical H Value (KM-Log)	2.301
KM Standard Error of Mean (logged)	0.189		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.816	Mean in Log Scale	-0.373
SD in Original Scale	0.549	SD in Log Scale	0.606
95% t UCL (Assumes normality)	1.183	95% H-Stat UCL	1.482

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 1.229

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	8
Number of Detects	8	Number of Non-Detects	9
Number of Distinct Detects	3	Number of Distinct Non-Detects	6
Minimum Detect	1	Minimum Non-Detect	0.08
Maximum Detect	1.7	Maximum Non-Detect	1
Variance Detects	0.0606	Percent Non-Detects	52.94%
Mean Detects	1.091	SD Detects	0.246
Median Detects	1	CV Detects	0.226
Skewness Detects	2.818	Kurtosis Detects	7.956
Mean of Logged Detects	0.07	SD of Logged Detects	0.186

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.442	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.473	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.556	KM Standard Error of Mean	0.137
KM SD	0.529	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.795	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.781	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.967	95% KM Chebyshev UCL	1.154
97.5% KM Chebyshev UCL	1.412	99% KM Chebyshev UCL	1.92

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.329	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.716	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.472	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.294	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	29.07	k star (bias corrected MLE)	18.25
Theta hat (MLE)	0.0375	Theta star (bias corrected MLE)	0.0598
nu hat (MLE)	465.1	nu star (bias corrected)	292
Mean (detects)	1.091		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.419	Mean	0.83
Maximum	1.7	Median	0.742
SD	0.308	CV	0.371
k hat (MLE)	8.723	k star (bias corrected MLE)	7.223
Theta hat (MLE)	0.0951	Theta star (bias corrected MLE)	0.115
nu hat (MLE)	296.6	nu star (bias corrected)	245.6
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (245.58, α)	210.3	Adjusted Chi Square Value (245.58, β)	206.9
95% Gamma Approximate UCL (use when n>=50)	0.969	95% Gamma Adjusted UCL (use when n<50)	0.985

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.556	SD (KM)	0.529
Variance (KM)	0.28	SE of Mean (KM)	0.137
k hat (KM)	1.105	k star (KM)	0.949
nu hat (KM)	37.56	nu star (KM)	32.26
theta hat (KM)	0.503	theta star (KM)	0.586
80% gamma percentile (KM)	0.898	90% gamma percentile (KM)	1.297
95% gamma percentile (KM)	1.696	99% gamma percentile (KM)	2.629

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (32.26, α)	20.28	Adjusted Chi Square Value (32.26, β)	19.29
95% Gamma Approximate KM-UCL (use when n>=50)	0.884	95% Gamma Adjusted KM-UCL (use when n<50)	0.93

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.449	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.461	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.893	Mean in Log Scale	-0.145
SD in Original Scale	0.255	SD in Log Scale	0.249
95% t UCL (assumes normality of ROS data)	1.001	95% Percentile Bootstrap UCL	1
95% BCA Bootstrap UCL	1.035	95% Bootstrap t UCL	1.051
95% H-UCL (Log ROS)	1		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.304	KM Geo Mean	0.271
KM SD (logged)	1.301	95% Critical H Value (KM-Log)	3.146
KM Standard Error of Mean (logged)	0.337	95% H-UCL (KM -Log)	1.761
KM SD (logged)	1.301	95% Critical H Value (KM-Log)	3.146
KM Standard Error of Mean (logged)	0.337		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.729	Mean in Log Scale	-0.532
SD in Original Scale	0.402	SD in Log Scale	0.832
95% t UCL (Assumes normality)	0.9	95% H-Stat UCL	1.368

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.795	KM H-UCL	1.761
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chromium (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	7.83	Mean	17.05
Maximum	39	Median	15.55
SD	9.261	Std. Error of Mean	2.315
Coefficient of Variation	0.543	Skewness	1.074

Normal GOF Test

Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.208	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	21.11	95% Adjusted-CLT UCL (Chen-1995)	21.52
		95% Modified-t UCL (Johnson-1978)	21.21

Gamma GOF Test

A-D Test Statistic	0.636	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.221	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.216	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.093	k star (bias corrected MLE)	3.367
Theta hat (MLE)	4.165	Theta star (bias corrected MLE)	5.063
nu hat (MLE)	131	nu star (bias corrected)	107.7
MLE Mean (bias corrected)	17.05	MLE Sd (bias corrected)	9.291
		Approximate Chi Square Value (0.05)	84.79
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	82.48

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	21.66	95% Adjusted Gamma UCL (use when n<50)	22.27

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.058	Mean of logged Data	2.709
Maximum of Logged Data	3.664	SD of logged Data	0.512

Assuming Lognormal Distribution

95% H-UCL	22.49	90% Chebyshev (MVUE) UCL	23.7
95% Chebyshev (MVUE) UCL	26.75	97.5% Chebyshev (MVUE) UCL	30.99
99% Chebyshev (MVUE) UCL	39.31		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	20.86	95% Jackknife UCL	21.11
95% Standard Bootstrap UCL	20.63	95% Bootstrap-t UCL	21.98
95% Hall's Bootstrap UCL	21.91	95% Percentile Bootstrap UCL	21.06
95% BCA Bootstrap UCL	21.47		
90% Chebyshev(Mean, Sd) UCL	23.99	95% Chebyshev(Mean, Sd) UCL	27.14
97.5% Chebyshev(Mean, Sd) UCL	31.51	99% Chebyshev(Mean, Sd) UCL	40.08

Suggested UCL to Use

95% Student's-t UCL 21.11

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Number of Detects	5	Number of Non-Detects	3
Number of Distinct Detects	5	Number of Distinct Non-Detects	3
Minimum Detect	5.8	Minimum Non-Detect	7.03
Maximum Detect	100	Maximum Non-Detect	9.19
Variance Detects	1604	Percent Non-Detects	37.5%
Mean Detects	28.6	SD Detects	40.05
Median Detects	12.5	CV Detects	1.4
Skewness Detects	2.198	Kurtosis Detects	4.866
Mean of Logged Detects	2.776	SD of Logged Detects	1.081

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.633	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.436	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	20.05	KM Standard Error of Mean	12.01
KM SD	30.4	95% KM (BCA) UCL	43.81
95% KM (t) UCL	42.81	95% KM (Percentile Bootstrap) UCL	42.49
95% KM (z) UCL	39.81	95% KM Bootstrap t UCL	147.6
90% KM Chebyshev UCL	56.09	95% KM Chebyshev UCL	72.42
97.5% KM Chebyshev UCL	95.08	99% KM Chebyshev UCL	139.6

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.74	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.691	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.398	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.364	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.999	k star (bias corrected MLE)	0.533
Theta hat (MLE)	28.62	Theta star (bias corrected MLE)	53.65
nu hat (MLE)	9.995	nu star (bias corrected)	5.331
Mean (detects)	28.6		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	17.88
Maximum	100	Median	7.9
SD	33.7	CV	1.885
k hat (MLE)	0.247	k star (bias corrected MLE)	0.238
Theta hat (MLE)	72.26	Theta star (bias corrected MLE)	75.13
nu hat (MLE)	3.959	nu star (bias corrected)	3.807
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (3.81, α)	0.647	Adjusted Chi Square Value (3.81, β)	0.391
95% Gamma Approximate UCL (use when n>=50)	105.2	95% Gamma Adjusted UCL (use when n<50)	174.2

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	20.05	SD (KM)	30.4
Variance (KM)	923.9	SE of Mean (KM)	12.01
k hat (KM)	0.435	k star (KM)	0.355
nu hat (KM)	6.962	nu star (KM)	5.685
theta hat (KM)	46.08	theta star (KM)	56.43
80% gamma percentile (KM)	31.83	90% gamma percentile (KM)	57.76
95% gamma percentile (KM)	86.75	99% gamma percentile (KM)	160.6

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.68, α)	1.481	Adjusted Chi Square Value (5.68, β)	1.006
95% Gamma Approximate KM-UCL (use when n>=50)	76.97	95% Gamma Adjusted KM-UCL (use when n<50)	113.2

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.332	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	19.35	Mean in Log Scale	2.248
SD in Original Scale	32.86	SD in Log Scale	1.095
95% t UCL (assumes normality of ROS data)	41.36	95% Percentile Bootstrap UCL	42.06
95% BCA Bootstrap UCL	53.27	95% Bootstrap t UCL	140
95% H-UCL (Log ROS)	78.5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.394	KM Geo Mean	10.96
KM SD (logged)	0.91	95% Critical H Value (KM-Log)	3.207
KM Standard Error of Mean (logged)	0.36	95% H-UCL (KM -Log)	49.92
KM SD (logged)	0.91	95% Critical H Value (KM-Log)	3.207
KM Standard Error of Mean (logged)	0.36		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	19.35	Mean in Log Scale	2.245
SD in Original Scale	32.86	SD in Log Scale	1.101
95% t UCL (Assumes normality)	41.36	95% H-Stat UCL	79.89

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 72.42

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	4.2	Mean	8.331
Maximum	18.7	Median	7.68
SD	3.517	Std. Error of Mean	0.879
Coefficient of Variation	0.422	Skewness	1.767

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.17	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	9.873	95% Adjusted-CLT UCL (Chen-1995)	10.19
		95% Modified-t UCL (Johnson-1978)	9.937

Gamma GOF Test

A-D Test Statistic	0.276	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.114	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.326	k star (bias corrected MLE)	5.994
Theta hat (MLE)	1.137	Theta star (bias corrected MLE)	1.39
nu hat (MLE)	234.4	nu star (bias corrected)	191.8
MLE Mean (bias corrected)	8.331	MLE Sd (bias corrected)	3.403
		Approximate Chi Square Value (0.05)	160.8
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	157.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	9.94	95% Adjusted Gamma UCL (use when n<50)	10.14

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.093	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.435	Mean of logged Data	2.05
Maximum of Logged Data	2.929	SD of logged Data	0.375

Assuming Lognormal Distribution

95% H-UCL	10.05	90% Chebyshev (MVUE) UCL	10.67
95% Chebyshev (MVUE) UCL	11.75	97.5% Chebyshev (MVUE) UCL	13.24
99% Chebyshev (MVUE) UCL	16.17		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	9.778	95% Jackknife UCL	9.873
95% Standard Bootstrap UCL	9.795	95% Bootstrap-t UCL	10.59
95% Hall's Bootstrap UCL	15.68	95% Percentile Bootstrap UCL	9.825
95% BCA Bootstrap UCL	10.16		
90% Chebyshev(Mean, Sd) UCL	10.97	95% Chebyshev(Mean, Sd) UCL	12.16
97.5% Chebyshev(Mean, Sd) UCL	13.82	99% Chebyshev(Mean, Sd) UCL	17.08

Suggested UCL to Use

95% Student's-t UCL 9.873

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	8240	Mean	13129
Maximum	21100	Median	11500
SD	4119	Std. Error of Mean	1030
Coefficient of Variation	0.314	Skewness	1.058

Normal GOF Test

Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	14934	95% Adjusted-CLT UCL (Chen-1995)	15113
		95% Modified-t UCL (Johnson-1978)	14979

Gamma GOF Test

A-D Test Statistic	0.659	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.172	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	12.21	k star (bias corrected MLE)	9.964
Theta hat (MLE)	1075	Theta star (bias corrected MLE)	1318
nu hat (MLE)	390.8	nu star (bias corrected)	318.8
MLE Mean (bias corrected)	13129	MLE Sd (bias corrected)	4159
		Approximate Chi Square Value (0.05)	278.5
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	274.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	15032	95% Adjusted Gamma UCL (use when n<50)	15267

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.157	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.213	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	9.017	Mean of logged Data	9.441
Maximum of Logged Data	9.957	SD of logged Data	0.29

Assuming Lognormal Distribution

95% H-UCL	15108	90% Chebyshev (MVUE) UCL	15988
95% Chebyshev (MVUE) UCL	17295	97.5% Chebyshev (MVUE) UCL	19110
99% Chebyshev (MVUE) UCL	22674		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	14822	95% Jackknife UCL	14934
95% Standard Bootstrap UCL	14747	95% Bootstrap-t UCL	15336
95% Hall's Bootstrap UCL	14925	95% Percentile Bootstrap UCL	14850
95% BCA Bootstrap UCL	15033		
90% Chebyshev(Mean, Sd) UCL	16218	95% Chebyshev(Mean, Sd) UCL	17617
97.5% Chebyshev(Mean, Sd) UCL	19559	99% Chebyshev(Mean, Sd) UCL	23374

Suggested UCL to Use

95% Student's-t UCL 14934

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lead (mg/kg)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	11
Number of Detects	15	Number of Non-Detects	2
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	10	Minimum Non-Detect	10
Maximum Detect	31.8	Maximum Non-Detect	10
Variance Detects	29.84	Percent Non-Detects	11.76%
Mean Detects	14.19	SD Detects	5.463
Median Detects	13.8	CV Detects	0.385
Skewness Detects	2.608	Kurtosis Detects	8.296
Mean of Logged Detects	2.602	SD of Logged Detects	0.305

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.696	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	13.69	KM Standard Error of Mean	1.29
KM SD	5.138	95% KM (BCA) UCL	15.95
95% KM (t) UCL	15.95	95% KM (Percentile Bootstrap) UCL	15.97
95% KM (z) UCL	15.82	95% KM Bootstrap t UCL	17.75
90% KM Chebyshev UCL	17.56	95% KM Chebyshev UCL	19.32
97.5% KM Chebyshev UCL	21.75	99% KM Chebyshev UCL	26.53

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.894	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.737	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.188	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	10.17	k star (bias corrected MLE)	8.184
Theta hat (MLE)	1.394	Theta star (bias corrected MLE)	1.734
nu hat (MLE)	305.2	nu star (bias corrected)	245.5
Mean (detects)	14.19		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	3.971	Mean	13.07
Maximum	31.8	Median	12
SD	6.012	CV	0.46
k hat (MLE)	5.491	k star (bias corrected MLE)	4.561
Theta hat (MLE)	2.38	Theta star (bias corrected MLE)	2.865
nu hat (MLE)	186.7	nu star (bias corrected)	155.1
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (155.08, α)	127.3	Adjusted Chi Square Value (155.08, β)	124.7
95% Gamma Approximate UCL (use when n>=50)	15.92	95% Gamma Adjusted UCL (use when n<50)	16.26

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	13.69	SD (KM)	5.138
Variance (KM)	26.4	SE of Mean (KM)	1.29
k hat (KM)	7.104	k star (KM)	5.89
nu hat (KM)	241.6	nu star (KM)	200.3
theta hat (KM)	1.928	theta star (KM)	2.325
80% gamma percentile (KM)	18.08	90% gamma percentile (KM)	21.24
95% gamma percentile (KM)	24.1	99% gamma percentile (KM)	30.1

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (200.26, α)	168.5	Adjusted Chi Square Value (200.26, β)	165.5
95% Gamma Approximate KM-UCL (use when n>=50)	16.27	95% Gamma Adjusted KM-UCL (use when n<50)	16.57

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.838	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	13.32	Mean in Log Scale	2.522
SD in Original Scale	5.663	SD in Log Scale	0.365
95% t UCL (assumes normality of ROS data)	15.72	95% Percentile Bootstrap UCL	15.74
95% BCA Bootstrap UCL	16.39	95% Bootstrap t UCL	16.93
95% H-UCL (Log ROS)	15.85		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.567	KM Geo Mean	13.03
KM SD (logged)	0.293	95% Critical H Value (KM-Log)	1.856
KM Standard Error of Mean (logged)	0.0736	95% H-UCL (KM -Log)	15.58
KM SD (logged)	0.293	95% Critical H Value (KM-Log)	1.856
KM Standard Error of Mean (logged)	0.0736		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	13.11	Mean in Log Scale	2.486
SD in Original Scale	5.952	SD in Log Scale	0.436
95% t UCL (Assumes normality)	15.63	95% H-Stat UCL	16.37

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM Adjusted Gamma UCL	16.57	95% GROS Adjusted Gamma UCL	16.26

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	180	Mean	431.3
Maximum	896	Median	321.5
SD	209.7	Std. Error of Mean	52.43
Coefficient of Variation	0.486	Skewness	0.903

Normal GOF Test

Shapiro Wilk Test Statistic	0.887	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.26	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	523.2	95% Adjusted-CLT UCL (Chen-1995)	530.1
		95% Modified-t UCL (Johnson-1978)	525.1

Gamma GOF Test

A-D Test Statistic	0.586	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.24	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.216	Data Not Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.953	k star (bias corrected MLE)	4.066
Theta hat (MLE)	87.08	Theta star (bias corrected MLE)	106.1
nu hat (MLE)	158.5	nu star (bias corrected)	130.1
MLE Mean (bias corrected)	431.3	MLE Sd (bias corrected)	213.9
		Approximate Chi Square Value (0.05)	104.8
Adjusted Level of Significance	0.0335	Adjusted Chi Square Value	102.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	535.6	95% Adjusted Gamma UCL (use when n<50)	549.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.887	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.216	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.213	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.193	Mean of logged Data	5.962
Maximum of Logged Data	6.798	SD of logged Data	0.467

Assuming Lognormal Distribution

95% H-UCL	552.5	90% Chebyshev (MVUE) UCL	584.8
95% Chebyshev (MVUE) UCL	655	97.5% Chebyshev (MVUE) UCL	752.3
99% Chebyshev (MVUE) UCL	943.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	517.5	95% Jackknife UCL	523.2
95% Standard Bootstrap UCL	514.7	95% Bootstrap-t UCL	544.4
95% Hall's Bootstrap UCL	528.1	95% Percentile Bootstrap UCL	515.6
95% BCA Bootstrap UCL	530.9		
90% Chebyshev(Mean, Sd) UCL	588.5	95% Chebyshev(Mean, Sd) UCL	659.8
97.5% Chebyshev(Mean, Sd) UCL	758.6	99% Chebyshev(Mean, Sd) UCL	952.9

Suggested UCL to Use

95% Adjusted Gamma UCL 549.2

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	4
Number of Detects	1	Number of Non-Detects	5
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Mercury (mg/kg) was not processed!

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Molybdenum (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	10	Mean	55
Maximum	100	Median	55

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Molybdenum (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Nickel (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	13
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	10	Number of Distinct Non-Detects	4
Minimum Detect	8	Minimum Non-Detect	8
Maximum Detect	22.9	Maximum Non-Detect	12.8
Variance Detects	26.05	Percent Non-Detects	25%
Mean Detects	14.18	SD Detects	5.104
Median Detects	13	CV Detects	0.36
Skewness Detects	0.43	Kurtosis Detects	-1.317
Mean of Logged Detects	2.592	SD of Logged Detects	0.361

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.903	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	12.91	KM Standard Error of Mean	1.262
KM SD	4.801	95% KM (BCA) UCL	15
95% KM (t) UCL	15.12	95% KM (Percentile Bootstrap) UCL	14.99
95% KM (z) UCL	14.98	95% KM Bootstrap t UCL	15.59
90% KM Chebyshev UCL	16.69	95% KM Chebyshev UCL	18.41
97.5% KM Chebyshev UCL	20.79	99% KM Chebyshev UCL	25.46

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.54	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.224	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	8.536	k star (bias corrected MLE)	6.458
Theta hat (MLE)	1.661	Theta star (bias corrected MLE)	2.195
nu hat (MLE)	204.9	nu star (bias corrected)	155
Mean (detects)	14.18		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.098	Mean	12.65
Maximum	22.9	Median	10.15
SD	5.285	CV	0.418
k hat (MLE)	6.014	k star (bias corrected MLE)	4.928
Theta hat (MLE)	2.104	Theta star (bias corrected MLE)	2.568
nu hat (MLE)	192.4	nu star (bias corrected)	157.7
Adjusted Level of Significance (β)	0.0335		
Approximate Chi Square Value (157.69, α)	129.7	Adjusted Chi Square Value (157.69, β)	126.8
95% Gamma Approximate UCL (use when n>=50)	15.39	95% Gamma Adjusted UCL (use when n<50)	15.74

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	12.91	SD (KM)	4.801
Variance (KM)	23.05	SE of Mean (KM)	1.262
k hat (KM)	7.227	k star (KM)	5.914
nu hat (KM)	231.3	nu star (KM)	189.2
theta hat (KM)	1.786	theta star (KM)	2.183
80% gamma percentile (KM)	17.03	90% gamma percentile (KM)	20
95% gamma percentile (KM)	22.69	99% gamma percentile (KM)	28.33

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (189.24, α)	158.4	Adjusted Chi Square Value (189.24, β)	155.2
95% Gamma Approximate KM-UCL (use when n>=50)	15.42	95% Gamma Adjusted KM-UCL (use when n<50)	15.74

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.204	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	12.76	Mean in Log Scale	2.474
SD in Original Scale	5.124	SD in Log Scale	0.393
95% t UCL (assumes normality of ROS data)	15.01	95% Percentile Bootstrap UCL	14.89
95% BCA Bootstrap UCL	15.08	95% Bootstrap t UCL	15.38
95% H-UCL (Log ROS)	15.62		

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.494	KM Geo Mean	12.11
KM SD (logged)	0.35	95% Critical H Value (KM-Log)	1.911
KM Standard Error of Mean (logged)	0.0926	95% H-UCL (KM -Log)	15.3
KM SD (logged)	0.35	95% Critical H Value (KM-Log)	1.911
KM Standard Error of Mean (logged)	0.0926		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	12.06	Mean in Log Scale	2.376
SD in Original Scale	5.801	SD in Log Scale	0.506
95% t UCL (Assumes normality)	14.6	95% H-Stat UCL	15.99

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 15.12

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Number of Detects	3	Number of Non-Detects	5
Number of Distinct Detects	3	Number of Distinct Non-Detects	5
Minimum Detect	3.6	Minimum Non-Detect	4.7
Maximum Detect	14	Maximum Non-Detect	6.43
Variance Detects	30.45	Percent Non-Detects	62.5%
Mean Detects	9.867	SD Detects	5.518
Median Detects	12	CV Detects	0.559
Skewness Detects	-1.48	Kurtosis Detects	N/A
Mean of Logged Detects	2.135	SD of Logged Detects	0.744

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.317	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.95	KM Standard Error of Mean	1.776
KM SD	4.101	95% KM (BCA) UCL	N/A
95% KM (t) UCL	9.314	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	8.871	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	11.28	95% KM Chebyshev UCL	13.69
97.5% KM Chebyshev UCL	17.04	99% KM Chebyshev UCL	23.62

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	3.4	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.902	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	20.4	nu star (bias corrected)	N/A
Mean (detects)	9.867		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	3.6	Mean	6.079
Maximum	14	Median	3.806
SD	4.306	CV	0.708
k hat (MLE)	3.119	k star (bias corrected MLE)	2.032
Theta hat (MLE)	1.949	Theta star (bias corrected MLE)	2.991
nu hat (MLE)	49.9	nu star (bias corrected)	32.52
Adjusted Level of Significance (β)	0.0195		
Approximate Chi Square Value (32.52, α)	20.48	Adjusted Chi Square Value (32.52, β)	18.11
95% Gamma Approximate UCL (use when n>=50)	9.65	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.95	SD (KM)	4.101
Variance (KM)	16.82	SE of Mean (KM)	1.776
k hat (KM)	2.105	k star (KM)	1.399
nu hat (KM)	33.68	nu star (KM)	22.38
theta hat (KM)	2.826	theta star (KM)	4.253
80% gamma percentile (KM)	9.275	90% gamma percentile (KM)	12.61
95% gamma percentile (KM)	15.87	99% gamma percentile (KM)	23.25

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (22.38, α)	12.63	Adjusted Chi Square Value (22.38, β)	10.82
95% Gamma Approximate KM-UCL (use when n>=50)	10.55	95% Gamma Adjusted KM-UCL (use when n<50)	12.31

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.834	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.348	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	6.011	Mean in Log Scale	1.618
SD in Original Scale	4.347	SD in Log Scale	0.584
95% t UCL (assumes normality of ROS data)	8.922	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	10.4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.601	KM Geo Mean	4.959
KM SD (logged)	0.556	95% Critical H Value (KM-Log)	2.452
KM Standard Error of Mean (logged)	0.241	95% H-UCL (KM -Log)	9.691
KM SD (logged)	0.556	95% Critical H Value (KM-Log)	2.452
KM Standard Error of Mean (logged)	0.241		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	5.334	Mean in Log Scale	1.397
SD in Original Scale	4.781	SD in Log Scale	0.735
95% t UCL (Assumes normality)	8.537	95% H-Stat UCL	11.55

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	9.314

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
Number of Detects	2	Number of Non-Detects	6
Number of Distinct Detects	2	Number of Distinct Non-Detects	6
Minimum Detect	2	Minimum Non-Detect	0.4
Maximum Detect	8	Maximum Non-Detect	1.84
Variance Detects	18	Percent Non-Detects	75%
Mean Detects	5	SD Detects	4.243
Median Detects	5	CV Detects	0.849
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.386	SD of Logged Detects	0.98

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.55	KM Standard Error of Mean	1.247
KM SD	2.493	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.912	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.601	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	5.29	95% KM Chebyshev UCL	6.984
97.5% KM Chebyshev UCL	9.336	99% KM Chebyshev UCL	13.95

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.394	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.088	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	9.577	nu star (bias corrected)	N/A
Mean (detects)	5		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.55	SD (KM)	2.493
Variance (KM)	6.218	SE of Mean (KM)	1.247
k hat (KM)	0.386	k star (KM)	0.325
nu hat (KM)	6.183	nu star (KM)	5.197
theta hat (KM)	4.011	theta star (KM)	4.772
80% gamma percentile (KM)	2.42	90% gamma percentile (KM)	4.525
95% gamma percentile (KM)	6.909	99% gamma percentile (KM)	13.05

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0195
Approximate Chi Square Value (5.20, α)	1.244	Adjusted Chi Square Value (5.20, β)	0.825
95% Gamma Approximate KM-UCL (use when n>=50)	6.473	95% Gamma Adjusted KM-UCL (use when n<50)	9.769

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.271	Mean in Log Scale	-2.351
SD in Original Scale	2.805	SD in Log Scale	2.336
95% t UCL (assumes normality of ROS data)	3.15	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	766.1		

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.341	KM Geo Mean	0.711
KM SD (logged)	1.056	95% Critical H Value (KM-Log)	3.564
KM Standard Error of Mean (logged)	0.528	95% H-UCL (KM -Log)	5.147
KM SD (logged)	1.056	95% Critical H Value (KM-Log)	3.564
KM Standard Error of Mean (logged)	0.528		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.742	Mean in Log Scale	-0.0409
SD in Original Scale	2.58	SD in Log Scale	1.061
95% t UCL (Assumes normality)	3.47	95% H-Stat UCL	7.088

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 6.984

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	6	Number of Distinct Observations	6
		Number of Missing Observations	0
Minimum	15.2	Mean	20.62
Maximum	34.3	Median	17.45
SD	7.2	Std. Error of Mean	2.939
Coefficient of Variation	0.349	Skewness	1.826

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.774	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.303	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	26.54	95% Adjusted-CLT UCL (Chen-1995)	27.79
		95% Modified-t UCL (Johnson-1978)	26.9

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	0.61	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.302	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.03	k star (bias corrected MLE)	6.128
Theta hat (MLE)	1.713	Theta star (bias corrected MLE)	3.364
nu hat (MLE)	144.4	nu star (bias corrected)	73.54
MLE Mean (bias corrected)	20.62	MLE Sd (bias corrected)	8.328
		Approximate Chi Square Value (0.05)	54.79
Adjusted Level of Significance	0.0122	Adjusted Chi Square Value	48.99

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	27.67	95% Adjusted Gamma UCL (use when n<50)	30.95

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.837	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.788	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.281	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.325	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.721	Mean of logged Data	2.984
Maximum of Logged Data	3.535	SD of logged Data	0.303

Assuming Lognormal Distribution

95% H-UCL	28.01	90% Chebyshev (MVUE) UCL	28.16
95% Chebyshev (MVUE) UCL	31.62	97.5% Chebyshev (MVUE) UCL	36.41
99% Chebyshev (MVUE) UCL	45.83		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	25.45	95% Jackknife UCL	26.54
95% Standard Bootstrap UCL	24.97	95% Bootstrap-t UCL	47.32
95% Hall's Bootstrap UCL	53.57	95% Percentile Bootstrap UCL	25.45
95% BCA Bootstrap UCL	26.77		
90% Chebyshev(Mean, Sd) UCL	29.43	95% Chebyshev(Mean, Sd) UCL	33.43
97.5% Chebyshev(Mean, Sd) UCL	38.97	99% Chebyshev(Mean, Sd) UCL	49.86

Suggested UCL to Use

95% Student's-t UCL	26.54

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	25	Mean	120.7
Maximum	262	Median	120
SD	72.75	Std. Error of Mean	17.65
Coefficient of Variation	0.603	Skewness	0.434

Normal GOF Test

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.154	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	151.5	95% Adjusted-CLT UCL (Chen-1995)	151.7
		95% Modified-t UCL (Johnson-1978)	151.8

Gamma GOF Test

A-D Test Statistic	0.439	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.175	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.211	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.495	k star (bias corrected MLE)	2.094
Theta hat (MLE)	48.38	Theta star (bias corrected MLE)	57.65
nu hat (MLE)	84.84	nu star (bias corrected)	71.2
MLE Mean (bias corrected)	120.7	MLE Sd (bias corrected)	83.42
		Approximate Chi Square Value (0.05)	52.77
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	51.11

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	162.9	95% Adjusted Gamma UCL (use when n<50)	168.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.207	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Appendix D, Table 9. ProUCL Output - Neosho River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal Statistics

Minimum of Logged Data	3.219	Mean of logged Data	4.58
Maximum of Logged Data	5.568	SD of logged Data	0.724

Assuming Lognormal Distribution

95% H-UCL	191.5	90% Chebyshev (MVUE) UCL	194
95% Chebyshev (MVUE) UCL	225.5	97.5% Chebyshev (MVUE) UCL	269.3
99% Chebyshev (MVUE) UCL	355.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	149.7	95% Jackknife UCL	151.5
95% Standard Bootstrap UCL	148.6	95% Bootstrap-t UCL	154.5
95% Hall's Bootstrap UCL	151.2	95% Percentile Bootstrap UCL	148.8
95% BCA Bootstrap UCL	150.3		
90% Chebyshev(Mean, Sd) UCL	173.7	95% Chebyshev(Mean, Sd) UCL	197.6
97.5% Chebyshev(Mean, Sd) UCL	230.9	99% Chebyshev(Mean, Sd) UCL	296.3

Suggested UCL to Use

95% Student's-t UCL 151.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:04:43 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	113	Mean	3408
Maximum	11000	Median	3280
SD	2828	Std. Error of Mean	603
Coefficient of Variation	0.83	Skewness	0.985

Normal GOF Test

Shapiro Wilk Test Statistic	0.909	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4445	95% Adjusted-CLT UCL (Chen-1995)	4535
		95% Modified-t UCL (Johnson-1978)	4466

Gamma GOF Test

A-D Test Statistic	0.37	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.766	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.136	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.19	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.201	k star (bias corrected MLE)	1.068
Theta hat (MLE)	2837	Theta star (bias corrected MLE)	3192
nu hat (MLE)	52.85	nu star (bias corrected)	46.98
MLE Mean (bias corrected)	3408	MLE Sd (bias corrected)	3298
		Approximate Chi Square Value (0.05)	32.25
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	31.34

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4964	95% Adjusted Gamma UCL (use when n<50)	5108

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.179	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.727	Mean of logged Data	7.663
Maximum of Logged Data	9.306	SD of logged Data	1.16

Assuming Lognormal Distribution

95% H-UCL	8498	90% Chebyshev (MVUE) UCL	7390
95% Chebyshev (MVUE) UCL	8936	97.5% Chebyshev (MVUE) UCL	11082
99% Chebyshev (MVUE) UCL	15297		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4400	95% Jackknife UCL	4445
95% Standard Bootstrap UCL	4407	95% Bootstrap-t UCL	4622
95% Hall's Bootstrap UCL	4640	95% Percentile Bootstrap UCL	4387
95% BCA Bootstrap UCL	4511		
90% Chebyshev(Mean, Sd) UCL	5217	95% Chebyshev(Mean, Sd) UCL	6036
97.5% Chebyshev(Mean, Sd) UCL	7174	99% Chebyshev(Mean, Sd) UCL	9408

Suggested UCL to Use

95% Student's-t UCL 4445

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	15
Number of Detects	3	Number of Non-Detects	13
Number of Distinct Detects	3	Number of Distinct Non-Detects	12
Minimum Detect	0.41	Minimum Non-Detect	0.6
Maximum Detect	3	Maximum Non-Detect	11
Variance Detects	1.799	Percent Non-Detects	81.25%
Mean Detects	1.503	SD Detects	1.341
Median Detects	1.1	CV Detects	0.892
Skewness Detects	1.231	Kurtosis Detects	N/A
Mean of Logged Detects	0.101	SD of Logged Detects	0.995

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.957	KM Standard Error of Mean	0.474
KM SD	0.948	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.788	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.736	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	2.379	95% KM Chebyshev UCL	3.023
97.5% KM Chebyshev UCL	3.916	99% KM Chebyshev UCL	5.672

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1.778	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.846	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	10.67	nu star (bias corrected)	N/A
Mean (detects)	1.503		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.719
Maximum	3	Median	0.633
SD	0.651	CV	0.906
k hat (MLE)	1.468	k star (bias corrected MLE)	1.235
Theta hat (MLE)	0.49	Theta star (bias corrected MLE)	0.582
nu hat (MLE)	46.99	nu star (bias corrected)	39.51
Adjusted Level of Significance (β)	0.0335		
Approximate Chi Square Value (39.51, α)	26.11	Adjusted Chi Square Value (39.51, β)	24.88
95% Gamma Approximate UCL (use when n>=50)	1.088	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.957	SD (KM)	0.948
Variance (KM)	0.899	SE of Mean (KM)	0.474
k hat (KM)	1.019	k star (KM)	0.869
nu hat (KM)	32.59	nu star (KM)	27.82
theta hat (KM)	0.939	theta star (KM)	1.101
80% gamma percentile (KM)	1.556	90% gamma percentile (KM)	2.28
95% gamma percentile (KM)	3.012	99% gamma percentile (KM)	4.731

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (27.82, α)	16.79	Adjusted Chi Square Value (27.82, β)	15.81
95% Gamma Approximate KM-UCL (use when n>=50)	1.585	95% Gamma Adjusted KM-UCL (use when n<50)	1.683

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	1	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.175	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.74	Mean in Log Scale	-0.468
SD in Original Scale	0.627	SD in Log Scale	0.517
95% t UCL (assumes normality of ROS data)	1.015	95% Percentile Bootstrap UCL	1.023
95% BCA Bootstrap UCL	1.228	95% Bootstrap t UCL	1.823
95% H-UCL (Log ROS)	0.943		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.395	KM Geo Mean	0.673
KM SD (logged)	0.759	95% Critical H Value (KM-Log)	2.357
KM Standard Error of Mean (logged)	0.38	95% H-UCL (KM -Log)	1.426
KM SD (logged)	0.759	95% Critical H Value (KM-Log)	2.357
KM Standard Error of Mean (logged)	0.38		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.926	Mean in Log Scale	0.689
SD in Original Scale	1.823	SD in Log Scale	1.097
95% t UCL (Assumes normality)	3.725	95% H-Stat UCL	8.164

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 1.788

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	2.7	Mean	8.568
Maximum	19.6	Median	9.35
SD	3.871	Std. Error of Mean	0.825
Coefficient of Variation	0.452	Skewness	0.695

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.909	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	9.988	95% Adjusted-CLT UCL (Chen-1995)	10.06
		95% Modified-t UCL (Johnson-1978)	10.01

Gamma GOF Test

A-D Test Statistic	0.874	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.747	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.185	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.186	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.648	k star (bias corrected MLE)	4.045
Theta hat (MLE)	1.843	Theta star (bias corrected MLE)	2.118
nu hat (MLE)	204.5	nu star (bias corrected)	178
MLE Mean (bias corrected)	8.568	MLE Sd (bias corrected)	4.26
		Approximate Chi Square Value (0.05)	148.1
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	146.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	10.3	95% Adjusted Gamma UCL (use when n<50)	10.44

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.206	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.184	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	2.037
Maximum of Logged Data	2.976	SD of logged Data	0.511

Assuming Lognormal Distribution

95% H-UCL	10.93	90% Chebyshev (MVUE) UCL	11.63
95% Chebyshev (MVUE) UCL	12.97	97.5% Chebyshev (MVUE) UCL	14.82
99% Chebyshev (MVUE) UCL	18.47		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	9.926	95% Jackknife UCL	9.988
95% Standard Bootstrap UCL	9.927	95% Bootstrap-t UCL	10.01
95% Hall's Bootstrap UCL	10.32	95% Percentile Bootstrap UCL	9.941
95% BCA Bootstrap UCL	10.08		
90% Chebyshev(Mean, Sd) UCL	11.04	95% Chebyshev(Mean, Sd) UCL	12.17
97.5% Chebyshev(Mean, Sd) UCL	13.72	99% Chebyshev(Mean, Sd) UCL	16.78

Suggested UCL to Use

95% Student's-t UCL 9.988

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	14
Number of Detects	11	Number of Non-Detects	4
Number of Distinct Detects	11	Number of Distinct Non-Detects	3
Minimum Detect	26.2	Minimum Non-Detect	22.8
Maximum Detect	269	Maximum Non-Detect	33.8
Variance Detects	4564	Percent Non-Detects	26.67%
Mean Detects	97.2	SD Detects	67.55
Median Detects	104	CV Detects	0.695
Skewness Detects	1.664	Kurtosis Detects	4.03
Mean of Logged Detects	4.366	SD of Logged Detects	0.702

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.825	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.26	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	77.73	KM Standard Error of Mean	17.31
KM SD	63.92	95% KM (BCA) UCL	109.7
95% KM (t) UCL	108.2	95% KM (Percentile Bootstrap) UCL	108.5
95% KM (z) UCL	106.2	95% KM Bootstrap t UCL	120.9
90% KM Chebyshev UCL	129.7	95% KM Chebyshev UCL	153.2
97.5% KM Chebyshev UCL	185.8	99% KM Chebyshev UCL	250

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.409	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.185	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.258	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.521	k star (bias corrected MLE)	1.894
Theta hat (MLE)	38.56	Theta star (bias corrected MLE)	51.32
nu hat (MLE)	55.46	nu star (bias corrected)	41.67
Mean (detects)	97.2		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	71.96
Maximum	269	Median	65.7
SD	71.68	CV	0.996
k hat (MLE)	0.439	k star (bias corrected MLE)	0.396
Theta hat (MLE)	163.8	Theta star (bias corrected MLE)	181.7
nu hat (MLE)	13.18	nu star (bias corrected)	11.88
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (11.88, α)	5.148	Adjusted Chi Square Value (11.88, β)	4.613
95% Gamma Approximate UCL (use when n>=50)	166.1	95% Gamma Adjusted UCL (use when n<50)	185.3

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	77.73	SD (KM)	63.92
Variance (KM)	4085	SE of Mean (KM)	17.31
k hat (KM)	1.479	k star (KM)	1.228
nu hat (KM)	44.38	nu star (KM)	36.83
theta hat (KM)	52.55	theta star (KM)	63.31
80% gamma percentile (KM)	122.8	90% gamma percentile (KM)	170.1
95% gamma percentile (KM)	216.8	99% gamma percentile (KM)	323.4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (36.83, α)	23.94	Adjusted Chi Square Value (36.83, β)	22.67
95% Gamma Approximate KM-UCL (use when n>=50)	119.6	95% Gamma Adjusted KM-UCL (use when n<50)	126.3

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.2	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	76.3	Mean in Log Scale	3.975
SD in Original Scale	67.48	SD in Log Scale	0.906
95% t UCL (assumes normality of ROS data)	107	95% Percentile Bootstrap UCL	105.1
95% BCA Bootstrap UCL	112.7	95% Bootstrap t UCL	120.9
95% H-UCL (Log ROS)	150.5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.05	KM Geo Mean	57.42
KM SD (logged)	0.777	95% Critical H Value (KM-Log)	2.41
KM Standard Error of Mean (logged)	0.211	95% H-UCL (KM -Log)	128
KM SD (logged)	0.777	95% Critical H Value (KM-Log)	2.41
KM Standard Error of Mean (logged)	0.211		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	74.93	Mean in Log Scale	3.897
SD in Original Scale	68.71	SD in Log Scale	1.003
95% t UCL (Assumes normality)	106.2	95% H-Stat UCL	170

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	126.3	95% GROS Adjusted Gamma UCL	185.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	15
Number of Detects	15	Number of Non-Detects	3
Number of Distinct Detects	13	Number of Distinct Non-Detects	2
Minimum Detect	0.031	Minimum Non-Detect	0.6
Maximum Detect	2	Maximum Non-Detect	0.663
Variance Detects	0.345	Percent Non-Detects	16.67%
Mean Detects	0.844	SD Detects	0.587
Median Detects	0.9	CV Detects	0.695
Skewness Detects	0.375	Kurtosis Detects	-0.518
Mean of Logged Detects	-0.573	SD of Logged Detects	1.149

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.735	KM Standard Error of Mean	0.141
KM SD	0.574	95% KM (BCA) UCL	0.973
95% KM (t) UCL	0.98	95% KM (Percentile Bootstrap) UCL	0.963
95% KM (z) UCL	0.967	95% KM Bootstrap t UCL	1.009
90% KM Chebyshev UCL	1.157	95% KM Chebyshev UCL	1.348
97.5% KM Chebyshev UCL	1.614	99% KM Chebyshev UCL	2.135

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.487	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.756	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.226	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.383	k star (bias corrected MLE)	1.151
Theta hat (MLE)	0.61	Theta star (bias corrected MLE)	0.734
nu hat (MLE)	41.48	nu star (bias corrected)	34.52
Mean (detects)	0.844		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.031	Mean	0.747
Maximum	2	Median	0.76
SD	0.578	CV	0.774
k hat (MLE)	1.348	k star (bias corrected MLE)	1.161
Theta hat (MLE)	0.554	Theta star (bias corrected MLE)	0.644
nu hat (MLE)	48.54	nu star (bias corrected)	41.78
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (41.78, α)	27.97	Adjusted Chi Square Value (41.78, β)	26.88
95% Gamma Approximate UCL (use when n>=50)	1.116	95% Gamma Adjusted UCL (use when n<50)	1.161

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.735	SD (KM)	0.574
Variance (KM)	0.329	SE of Mean (KM)	0.141
k hat (KM)	1.644	k star (KM)	1.407
nu hat (KM)	59.17	nu star (KM)	50.64
theta hat (KM)	0.447	theta star (KM)	0.523
80% gamma percentile (KM)	1.146	90% gamma percentile (KM)	1.557
95% gamma percentile (KM)	1.958	99% gamma percentile (KM)	2.866

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (50.64, α)	35.3	Adjusted Chi Square Value (50.64, β)	34.07
95% Gamma Approximate KM-UCL (use when n>=50)	1.055	95% Gamma Adjusted KM-UCL (use when n<50)	1.093

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.733	Mean in Log Scale	-0.77
SD in Original Scale	0.591	SD in Log Scale	1.143
95% t UCL (assumes normality of ROS data)	0.975	95% Percentile Bootstrap UCL	0.958
95% BCA Bootstrap UCL	0.976	95% Bootstrap t UCL	1.015
95% H-UCL (Log ROS)	1.96		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.799	KM Geo Mean	0.45
KM SD (logged)	1.186	95% Critical H Value (KM-Log)	2.919
KM Standard Error of Mean (logged)	0.309	95% H-UCL (KM -Log)	2.103
KM SD (logged)	1.186	95% Critical H Value (KM-Log)	2.919
KM Standard Error of Mean (logged)	0.309		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.755	Mean in Log Scale	-0.672
SD in Original Scale	0.571	SD in Log Scale	1.068
95% t UCL (Assumes normality)	0.989	95% H-Stat UCL	1.835

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.98

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	19
Number of Detects	21	Number of Non-Detects	1
Number of Distinct Detects	18	Number of Distinct Non-Detects	1
Minimum Detect	1	Minimum Non-Detect	0.6
Maximum Detect	545	Maximum Non-Detect	0.6
Variance Detects	14524	Percent Non-Detects	4.545%
Mean Detects	41.32	SD Detects	120.5
Median Detects	6.2	CV Detects	2.917
Skewness Detects	4.068	Kurtosis Detects	17.18
Mean of Logged Detects	1.985	SD of Logged Detects	1.654

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.358	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.455	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	39.47	KM Standard Error of Mean	25.17
KM SD	115.2	95% KM (BCA) UCL	87.54
95% KM (t) UCL	82.78	95% KM (Percentile Bootstrap) UCL	88.47
95% KM (z) UCL	80.87	95% KM Bootstrap t UCL	560.5
90% KM Chebyshev UCL	115	95% KM Chebyshev UCL	149.2
97.5% KM Chebyshev UCL	196.7	99% KM Chebyshev UCL	289.9

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.257	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.829	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.294	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.203	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.382	k star (bias corrected MLE)	0.359
Theta hat (MLE)	108.2	Theta star (bias corrected MLE)	115.1
nu hat (MLE)	16.04	nu star (bias corrected)	15.08
Mean (detects)	41.32		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	39.44
Maximum	545	Median	5.8
SD	117.9	CV	2.99
k hat (MLE)	0.34	k star (bias corrected MLE)	0.324
Theta hat (MLE)	116.1	Theta star (bias corrected MLE)	121.8
nu hat (MLE)	14.95	nu star (bias corrected)	14.24
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (14.24, α)	6.738	Adjusted Chi Square Value (14.24, β)	6.354
95% Gamma Approximate UCL (use when n>=50)	83.37	95% Gamma Adjusted UCL (use when n<50)	88.4

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	39.47	SD (KM)	115.2
Variance (KM)	13275	SE of Mean (KM)	25.17
k hat (KM)	0.117	k star (KM)	0.132
nu hat (KM)	5.163	nu star (KM)	5.792
theta hat (KM)	336.4	theta star (KM)	299.8
80% gamma percentile (KM)	38.18	90% gamma percentile (KM)	114.4
95% gamma percentile (KM)	222.3	99% gamma percentile (KM)	544.4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (5.79, α)	1.535	Adjusted Chi Square Value (5.79, β)	1.378
95% Gamma Approximate KM-UCL (use when n>=50)	149	95% Gamma Adjusted KM-UCL (use when n<50)	165.9

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.127	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	39.45	Mean in Log Scale	1.803
SD in Original Scale	117.9	SD in Log Scale	1.826
95% t UCL (assumes normality of ROS data)	82.71	95% Percentile Bootstrap UCL	82.54
95% BCA Bootstrap UCL	110.8	95% Bootstrap t UCL	557.7
95% H-UCL (Log ROS)	151.2		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.872	KM Geo Mean	6.5
KM SD (logged)	1.661	95% Critical H Value (KM-Log)	3.607
KM Standard Error of Mean (logged)	0.363	95% H-UCL (KM -Log)	95.39
KM SD (logged)	1.661	95% Critical H Value (KM-Log)	3.607
KM Standard Error of Mean (logged)	0.363		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	39.45	Mean in Log Scale	1.84
SD in Original Scale	117.9	SD in Log Scale	1.752
95% t UCL (Assumes normality)	82.72	95% H-Stat UCL	123

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 149.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Number of Detects	21	Number of Non-Detects	1
Number of Distinct Detects	21	Number of Distinct Non-Detects	1

Minimum Detect	0.26	Minimum Non-Detect	2.97
Maximum Detect	49.2	Maximum Non-Detect	2.97
Variance Detects	239	Percent Non-Detects	4.545%
Mean Detects	20.55	SD Detects	15.46
Median Detects	18	CV Detects	0.752
Skewness Detects	0.699	Kurtosis Detects	-0.744
Mean of Logged Detects	2.601	SD of Logged Detects	1.2

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.172	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	19.69	KM Standard Error of Mean	3.335
KM SD	15.26	95% KM (BCA) UCL	25.17
95% KM (t) UCL	25.43	95% KM (Percentile Bootstrap) UCL	25.22
95% KM (z) UCL	25.18	95% KM Bootstrap t UCL	26.76
90% KM Chebyshev UCL	29.7	95% KM Chebyshev UCL	34.23
97.5% KM Chebyshev UCL	40.52	99% KM Chebyshev UCL	52.87

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.286	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0863	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.327	k star (bias corrected MLE)	1.169
Theta hat (MLE)	15.49	Theta star (bias corrected MLE)	17.59
nu hat (MLE)	55.71	nu star (bias corrected)	49.09
Mean (detects)	20.55		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.26	Mean	19.74
Maximum	49.2	Median	15.4
SD	15.57	CV	0.789
k hat (MLE)	1.234	k star (bias corrected MLE)	1.096
Theta hat (MLE)	16	Theta star (bias corrected MLE)	18.01
nu hat (MLE)	54.27	nu star (bias corrected)	48.21
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (48.21, α)	33.27	Adjusted Chi Square Value (48.21, β)	32.34
95% Gamma Approximate UCL (use when n>=50)	28.6	95% Gamma Adjusted UCL (use when n<50)	29.41

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	19.69	SD (KM)	15.26
Variance (KM)	232.9	SE of Mean (KM)	3.335
k hat (KM)	1.665	k star (KM)	1.468
nu hat (KM)	73.25	nu star (KM)	64.59
theta hat (KM)	11.83	theta star (KM)	13.41
80% gamma percentile (KM)	30.54	90% gamma percentile (KM)	41.25
95% gamma percentile (KM)	51.67	99% gamma percentile (KM)	75.22

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (64.59, α)	47.1	Adjusted Chi Square Value (64.59, β)	45.98
95% Gamma Approximate KM-UCL (use when n>=50)	27	95% Gamma Adjusted KM-UCL (use when n<50)	27.66

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	19.71	Mean in Log Scale	2.512
SD in Original Scale	15.6	SD in Log Scale	1.243
95% t UCL (assumes normality of ROS data)	25.43	95% Percentile Bootstrap UCL	25.37
95% BCA Bootstrap UCL	25.92	95% Bootstrap t UCL	26.71
95% H-UCL (Log ROS)	59.18		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.476	KM Geo Mean	11.9
KM SD (logged)	1.304	95% Critical H Value (KM-Log)	3.031
KM Standard Error of Mean (logged)	0.293	95% H-UCL (KM -Log)	66.01
KM SD (logged)	1.304	95% Critical H Value (KM-Log)	3.031
KM Standard Error of Mean (logged)	0.293		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	19.69	Mean in Log Scale	2.501
SD in Original Scale	15.62	SD in Log Scale	1.262
95% t UCL (Assumes normality)	25.42	95% H-Stat UCL	61.17

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 25.43

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	17
Number of Detects	13	Number of Non-Detects	5
Number of Distinct Detects	13	Number of Distinct Non-Detects	5
Minimum Detect	3.9	Minimum Non-Detect	5.7
Maximum Detect	100	Maximum Non-Detect	8.4
Variance Detects	619.6	Percent Non-Detects	27.78%
Mean Detects	18.85	SD Detects	24.89
Median Detects	12.4	CV Detects	1.321
Skewness Detects	3.354	Kurtosis Detects	11.69
Mean of Logged Detects	2.565	SD of Logged Detects	0.767

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.502	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.376	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	14.81	KM Standard Error of Mean	5.24
KM SD	21.35	95% KM (BCA) UCL	26.33
95% KM (t) UCL	23.92	95% KM (Percentile Bootstrap) UCL	24.58
95% KM (z) UCL	23.43	95% KM Bootstrap t UCL	44.91
90% KM Chebyshev UCL	30.53	95% KM Chebyshev UCL	37.65
97.5% KM Chebyshev UCL	47.53	99% KM Chebyshev UCL	66.94

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.221	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.75	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.241	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.492	k star (bias corrected MLE)	1.199
Theta hat (MLE)	12.63	Theta star (bias corrected MLE)	15.72
nu hat (MLE)	38.8	nu star (bias corrected)	31.18
Mean (detects)	18.85		

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	13.61
Maximum	100	Median	9.15
SD	22.64	CV	1.663
k hat (MLE)	0.333	k star (bias corrected MLE)	0.314
Theta hat (MLE)	40.91	Theta star (bias corrected MLE)	43.31
nu hat (MLE)	11.98	nu star (bias corrected)	11.32
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (11.32, α)	4.78	Adjusted Chi Square Value (11.32, β)	4.378
95% Gamma Approximate UCL (use when n>=50)	32.23	95% Gamma Adjusted UCL (use when n<50)	35.19

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	14.81	SD (KM)	21.35
Variance (KM)	455.8	SE of Mean (KM)	5.24
k hat (KM)	0.481	k star (KM)	0.438
nu hat (KM)	17.32	nu star (KM)	15.76
theta hat (KM)	30.78	theta star (KM)	33.82
80% gamma percentile (KM)	24.12	90% gamma percentile (KM)	41.13
95% gamma percentile (KM)	59.61	99% gamma percentile (KM)	105.7

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (15.76, α)	7.796	Adjusted Chi Square Value (15.76, β)	7.262
95% Gamma Approximate KM-UCL (use when n>=50)	29.94	95% Gamma Adjusted KM-UCL (use when n<50)	32.14

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.886	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	14.63	Mean in Log Scale	2.212
SD in Original Scale	22.05	SD in Log Scale	0.874
95% t UCL (assumes normality of ROS data)	23.67	95% Percentile Bootstrap UCL	24.38
95% BCA Bootstrap UCL	29.91	95% Bootstrap t UCL	43.6
95% H-UCL (Log ROS)	22.56		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.251	KM Geo Mean	9.501
KM SD (logged)	0.812	95% Critical H Value (KM-Log)	2.378
KM Standard Error of Mean (logged)	0.201	95% H-UCL (KM -Log)	21.11
KM SD (logged)	0.812	95% Critical H Value (KM-Log)	2.378
KM Standard Error of Mean (logged)	0.201		

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	14.54	Mean in Log Scale	2.185
SD in Original Scale	22.1	SD in Log Scale	0.905
95% t UCL (Assumes normality)	23.6	95% H-Stat UCL	23.19

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 21.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	2.4	Mean	8.933
Maximum	48.1	Median	6.73
SD	9.5	Std. Error of Mean	2.026
Coefficient of Variation	1.064	Skewness	3.633

Normal GOF Test

Shapiro Wilk Test Statistic	0.563	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.299	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	12.42	95% Adjusted-CLT UCL (Chen-1995)	13.94
		95% Modified-t UCL (Johnson-1978)	12.68

Gamma GOF Test

A-D Test Statistic	0.951	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.188	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	1.957	k star (bias corrected MLE)	1.721
Theta hat (MLE)	4.564	Theta star (bias corrected MLE)	5.191
nu hat (MLE)	86.12	nu star (bias corrected)	75.71
MLE Mean (bias corrected)	8.933	MLE Sd (bias corrected)	6.81
		Approximate Chi Square Value (0.05)	56.67
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	55.44

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	11.93	95% Adjusted Gamma UCL (use when n<50)	12.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.126	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.875	Mean of logged Data	1.913
Maximum of Logged Data	3.873	SD of logged Data	0.688

Assuming Lognormal Distribution

95% H-UCL	11.93	90% Chebyshev (MVUE) UCL	12.46
95% Chebyshev (MVUE) UCL	14.27	97.5% Chebyshev (MVUE) UCL	16.78
99% Chebyshev (MVUE) UCL	21.7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	12.26	95% Jackknife UCL	12.42
95% Standard Bootstrap UCL	12.13	95% Bootstrap-t UCL	17.37
95% Hall's Bootstrap UCL	26.61	95% Percentile Bootstrap UCL	12.68
95% BCA Bootstrap UCL	14.6		
90% Chebyshev(Mean, Sd) UCL	15.01	95% Chebyshev(Mean, Sd) UCL	17.76
97.5% Chebyshev(Mean, Sd) UCL	21.58	99% Chebyshev(Mean, Sd) UCL	29.09

Suggested UCL to Use

95% Adjusted Gamma UCL 12.2

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Iron (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	4640	Mean	18427
Maximum	40100	Median	18900
SD	11084	Std. Error of Mean	2363
Coefficient of Variation	0.601	Skewness	0.452

Normal GOF Test

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.146	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	22493	95% Adjusted-CLT UCL (Chen-1995)	22557
		95% Modified-t UCL (Johnson-1978)	22531

Gamma GOF Test

A-D Test Statistic	0.409	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.131	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.187	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.584	k star (bias corrected MLE)	2.262
Theta hat (MLE)	7131	Theta star (bias corrected MLE)	8146
nu hat (MLE)	113.7	nu star (bias corrected)	99.53
MLE Mean (bias corrected)	18427	MLE Sd (bias corrected)	12252
		Approximate Chi Square Value (0.05)	77.51
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	76.06

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	23661	95% Adjusted Gamma UCL (use when n<50)	24112

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.164	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.442	Mean of logged Data	9.616
Maximum of Logged Data	10.6	SD of logged Data	0.694

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	26611	90% Chebyshev (MVUE) UCL	27775
95% Chebyshev (MVUE) UCL	31825	97.5% Chebyshev (MVUE) UCL	37447
99% Chebyshev (MVUE) UCL	48490		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	22314	95% Jackknife UCL	22493
95% Standard Bootstrap UCL	22227	95% Bootstrap-t UCL	22775
95% Hall's Bootstrap UCL	22475	95% Percentile Bootstrap UCL	22366
95% BCA Bootstrap UCL	22319		
90% Chebyshev(Mean, Sd) UCL	25516	95% Chebyshev(Mean, Sd) UCL	28728
97.5% Chebyshev(Mean, Sd) UCL	33185	99% Chebyshev(Mean, Sd) UCL	41939

Suggested UCL to Use

95% Student's-t UCL 22493

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	11.4	Mean	94.85
Maximum	586	Median	40.5
SD	126.4	Std. Error of Mean	26.94
Coefficient of Variation	1.332	Skewness	3.105

Normal GOF Test

Shapiro Wilk Test Statistic	0.624	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.255	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	141.2	95% Adjusted-CLT UCL (Chen-1995)	158.2
		95% Modified-t UCL (Johnson-1978)	144.2

Gamma GOF Test

A-D Test Statistic	0.702	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.769	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.206	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.19	Data Not Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	1.058	k star (bias corrected MLE)	0.944
Theta hat (MLE)	89.63	Theta star (bias corrected MLE)	100.4
nu hat (MLE)	46.56	nu star (bias corrected)	41.55
MLE Mean (bias corrected)	94.85	MLE Sd (bias corrected)	97.61
		Approximate Chi Square Value (0.05)	27.77
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	26.93

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	141.9	95% Adjusted Gamma UCL (use when n<50)	146.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.434	Mean of logged Data	4.01
Maximum of Logged Data	6.373	SD of logged Data	1.025

Assuming Lognormal Distribution

95% H-UCL	167.6	90% Chebyshev (MVUE) UCL	157
95% Chebyshev (MVUE) UCL	187.3	97.5% Chebyshev (MVUE) UCL	229.4
99% Chebyshev (MVUE) UCL	312		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	139.2	95% Jackknife UCL	141.2
95% Standard Bootstrap UCL	138	95% Bootstrap-t UCL	194.5
95% Hall's Bootstrap UCL	327.7	95% Percentile Bootstrap UCL	144.6
95% BCA Bootstrap UCL	168.5		
90% Chebyshev(Mean, Sd) UCL	175.7	95% Chebyshev(Mean, Sd) UCL	212.3
97.5% Chebyshev(Mean, Sd) UCL	263.1	99% Chebyshev(Mean, Sd) UCL	362.9

Suggested UCL to Use

95% Adjusted Gamma UCL 146.3

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Manganese (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	29	Mean	424.7
Maximum	1490	Median	445
SD	348	Std. Error of Mean	74.19
Coefficient of Variation	0.82	Skewness	1.32

Normal GOF Test

Shapiro Wilk Test Statistic	0.881	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	552.3	95% Adjusted-CLT UCL (Chen-1995)	569
		95% Modified-t UCL (Johnson-1978)	555.8

Gamma GOF Test

A-D Test Statistic	0.446	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.763	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.159	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.189	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.339	k star (bias corrected MLE)	1.186
Theta hat (MLE)	317.2	Theta star (bias corrected MLE)	357.9
nu hat (MLE)	58.9	nu star (bias corrected)	52.2
MLE Mean (bias corrected)	424.7	MLE Sd (bias corrected)	389.9
		Approximate Chi Square Value (0.05)	36.61
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	35.63

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	605.6	95% Adjusted Gamma UCL (use when n<50)	622.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.195	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.367	Mean of logged Data	5.633
Maximum of Logged Data	7.307	SD of logged Data	1.061

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	910.7	90% Chebyshev (MVUE) UCL	838.2
95% Chebyshev (MVUE) UCL	1004	97.5% Chebyshev (MVUE) UCL	1233
99% Chebyshev (MVUE) UCL	1685		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	546.7	95% Jackknife UCL	552.3
95% Standard Bootstrap UCL	547.7	95% Bootstrap-t UCL	581.3
95% Hall's Bootstrap UCL	609.9	95% Percentile Bootstrap UCL	546.3
95% BCA Bootstrap UCL	566.2		
90% Chebyshev(Mean, Sd) UCL	647.2	95% Chebyshev(Mean, Sd) UCL	748.1
97.5% Chebyshev(Mean, Sd) UCL	888	99% Chebyshev(Mean, Sd) UCL	1163

Suggested UCL to Use

95% Student's-t UCL 552.3

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	13
Number of Detects	5	Number of Non-Detects	11
Number of Distinct Detects	4	Number of Distinct Non-Detects	10
Minimum Detect	0.18	Minimum Non-Detect	0.067
Maximum Detect	1.1	Maximum Non-Detect	0.209
Variance Detects	0.163	Percent Non-Detects	68.75%
Mean Detects	0.378	SD Detects	0.404
Median Detects	0.2	CV Detects	1.068
Skewness Detects	2.232	Kurtosis Detects	4.986
Mean of Logged Detects	-1.28	SD of Logged Detects	0.771

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.578	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.461	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.166	KM Standard Error of Mean	0.0694
KM SD	0.248	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.288	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.28	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.374	95% KM Chebyshev UCL	0.468
97.5% KM Chebyshev UCL	0.599	99% KM Chebyshev UCL	0.856

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.185	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.685	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.474	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.361	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.777	k star (bias corrected MLE)	0.844
Theta hat (MLE)	0.213	Theta star (bias corrected MLE)	0.448
nu hat (MLE)	17.77	nu star (bias corrected)	8.443
Mean (detects)	0.378		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.125
Maximum	1.1	Median	0.01
SD	0.273	CV	2.184
k hat (MLE)	0.437	k star (bias corrected MLE)	0.396
Theta hat (MLE)	0.286	Theta star (bias corrected MLE)	0.315
nu hat (MLE)	13.97	nu star (bias corrected)	12.68
Adjusted Level of Significance (β)	0.0335		
Approximate Chi Square Value (12.68, α)	5.68	Adjusted Chi Square Value (12.68, β)	5.155
95% Gamma Approximate UCL (use when n>=50)	0.279	95% Gamma Adjusted UCL (use when n<50)	0.308

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.166	SD (KM)	0.248
Variance (KM)	0.0614	SE of Mean (KM)	0.0694
k hat (KM)	0.449	k star (KM)	0.406
nu hat (KM)	14.36	nu star (KM)	13
theta hat (KM)	0.37	theta star (KM)	0.409
80% gamma percentile (KM)	0.268	90% gamma percentile (KM)	0.468
95% gamma percentile (KM)	0.686	99% gamma percentile (KM)	1.234

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (13.00, α)	5.894	Adjusted Chi Square Value (13.00, β)	5.357
95% Gamma Approximate KM-UCL (use when n>=50)	0.366	95% Gamma Adjusted KM-UCL (use when n<50)	0.403

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.621	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.442	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.145	Mean in Log Scale	-2.64
SD in Original Scale	0.264	SD in Log Scale	1.043
95% t UCL (assumes normality of ROS data)	0.261	95% Percentile Bootstrap UCL	0.258
95% BCA Bootstrap UCL	0.329	95% Bootstrap t UCL	0.539
95% H-UCL (Log ROS)	0.259		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.243	KM Geo Mean	0.106
KM SD (logged)	0.766	95% Critical H Value (KM-Log)	2.365
KM Standard Error of Mean (logged)	0.216	95% H-UCL (KM -Log)	0.227
KM SD (logged)	0.766	95% Critical H Value (KM-Log)	2.365
KM Standard Error of Mean (logged)	0.216		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.162	Mean in Log Scale	-2.325
SD in Original Scale	0.258	SD in Log Scale	0.882
95% t UCL (Assumes normality)	0.275	95% H-Stat UCL	0.257

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.468

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	10	Mean	55
Maximum	100	Median	55

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Molybdenum (mg/kg) was not processed!

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Nickel (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	20
Number of Detects	21	Number of Non-Detects	1
Number of Distinct Detects	19	Number of Distinct Non-Detects	1
Minimum Detect	1.1	Minimum Non-Detect	5.3
Maximum Detect	35.4	Maximum Non-Detect	5.3
Variance Detects	89.49	Percent Non-Detects	4.545%
Mean Detects	15.96	SD Detects	9.46
Median Detects	14.2	CV Detects	0.593
Skewness Detects	0.657	Kurtosis Detects	-0.36
Mean of Logged Detects	2.55	SD of Logged Detects	0.783

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	15.37	KM Standard Error of Mean	2.061
KM SD	9.421	95% KM (BCA) UCL	19.02
95% KM (t) UCL	18.92	95% KM (Percentile Bootstrap) UCL	18.72
95% KM (z) UCL	18.76	95% KM Bootstrap t UCL	19.3
90% KM Chebyshev UCL	21.56	95% KM Chebyshev UCL	24.36
97.5% KM Chebyshev UCL	28.25	99% KM Chebyshev UCL	35.88

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.242	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.115	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.191	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.428	k star (bias corrected MLE)	2.113
Theta hat (MLE)	6.572	Theta star (bias corrected MLE)	7.552
nu hat (MLE)	102	nu star (bias corrected)	88.76
Mean (detects)	15.96		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	1.1	Mean	15.38
Maximum	35.4	Median	13.45
SD	9.619	CV	0.625
k hat (MLE)	2.195	k star (bias corrected MLE)	1.926
Theta hat (MLE)	7.01	Theta star (bias corrected MLE)	7.989
nu hat (MLE)	96.56	nu star (bias corrected)	84.72
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (84.72, α)	64.51	Adjusted Chi Square Value (84.72, β)	63.19
95% Gamma Approximate UCL (use when n>=50)	20.2	95% Gamma Adjusted UCL (use when n<50)	20.63

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	15.37	SD (KM)	9.421
Variance (KM)	88.76	SE of Mean (KM)	2.061
k hat (KM)	2.662	k star (KM)	2.33
nu hat (KM)	117.1	nu star (KM)	102.5
theta hat (KM)	5.774	theta star (KM)	6.599
80% gamma percentile (KM)	22.6	90% gamma percentile (KM)	28.86
95% gamma percentile (KM)	34.77	99% gamma percentile (KM)	47.78

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (102.51, α)	80.14	Adjusted Chi Square Value (102.51, β)	78.67
95% Gamma Approximate KM-UCL (use when n>=50)	19.66	95% Gamma Adjusted KM-UCL (use when n<50)	20.03

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	15.39	Mean in Log Scale	2.491
SD in Original Scale	9.608	SD in Log Scale	0.813
95% t UCL (assumes normality of ROS data)	18.92	95% Percentile Bootstrap UCL	18.71
95% BCA Bootstrap UCL	19.01	95% Bootstrap t UCL	19.27
95% H-UCL (Log ROS)	25.42		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.473	KM Geo Mean	11.86
KM SD (logged)	0.841	95% Critical H Value (KM-Log)	2.373
KM Standard Error of Mean (logged)	0.189	95% H-UCL (KM -Log)	26.12
KM SD (logged)	0.841	95% Critical H Value (KM-Log)	2.373
KM Standard Error of Mean (logged)	0.189		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	15.35	Mean in Log Scale	2.479
SD in Original Scale	9.658	SD in Log Scale	0.834
95% t UCL (Assumes normality)	18.9	95% H-Stat UCL	25.97

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use
95% KM (t) UCL 18.92

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	16
Number of Detects	2	Number of Non-Detects	16
Number of Distinct Detects	2	Number of Distinct Non-Detects	14
Minimum Detect	12	Minimum Non-Detect	0.6
Maximum Detect	14	Maximum Non-Detect	6.4
Variance Detects	2	Percent Non-Detects	88.89%
Mean Detects	13	SD Detects	1.414
Median Detects	13	CV Detects	0.109
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	2.562	SD of Logged Detects	0.109

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.978	KM Standard Error of Mean	1.304
KM SD	3.911	95% KM (BCA) UCL	N/A
95% KM (t) UCL	4.246	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	4.122	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	5.889	95% KM Chebyshev UCL	7.661
97.5% KM Chebyshev UCL	10.12	99% KM Chebyshev UCL	14.95

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	168.7	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0771	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	674.7	nu star (bias corrected)	N/A
Mean (detects)	13		

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.978	SD (KM)	3.911
Variance (KM)	15.3	SE of Mean (KM)	1.304
k hat (KM)	0.256	k star (KM)	0.25
nu hat (KM)	9.205	nu star (KM)	9.005
theta hat (KM)	7.735	theta star (KM)	7.907
80% gamma percentile (KM)	2.873	90% gamma percentile (KM)	5.936
95% gamma percentile (KM)	9.572	99% gamma percentile (KM)	19.25

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (9.00, α)	3.33	Adjusted Chi Square Value (9.00, β)	3.006
95% Gamma Approximate KM-UCL (use when n>=50)	5.349	95% Gamma Adjusted KM-UCL (use when n<50)	5.925

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	6.656	Mean in Log Scale	1.853
SD in Original Scale	2.385	SD in Log Scale	0.273
95% t UCL (assumes normality of ROS data)	7.634	95% Percentile Bootstrap UCL	7.608
95% BCA Bootstrap UCL	7.957	95% Bootstrap t UCL	10.75
95% H-UCL (Log ROS)	7.477		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.169	KM Geo Mean	0.844
KM SD (logged)	0.966	95% Critical H Value (KM-Log)	2.589
KM Standard Error of Mean (logged)	0.322	95% H-UCL (KM -Log)	2.469
KM SD (logged)	0.966	95% Critical H Value (KM-Log)	2.589
KM Standard Error of Mean (logged)	0.322		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	3.242	Mean in Log Scale	0.727
SD in Original Scale	3.67	SD in Log Scale	1.012
95% t UCL (Assumes normality)	4.747	95% H-Stat UCL	6.618

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	4.246	KM H-UCL	2.469
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Silver (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	11
Number of Detects	2	Number of Non-Detects	16
Number of Distinct Detects	2	Number of Distinct Non-Detects	9
Minimum Detect	2	Minimum Non-Detect	1.08
Maximum Detect	8	Maximum Non-Detect	1.8
Variance Detects	18	Percent Non-Detects	88.89%
Mean Detects	5	SD Detects	4.243
Median Detects	5	CV Detects	0.849
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.386	SD of Logged Detects	0.98

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.516	KM Standard Error of Mean	0.529
KM SD	1.587	95% KM (BCA) UCL	N/A
95% KM (t) UCL	2.436	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	2.386	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	3.102	95% KM Chebyshev UCL	3.821
97.5% KM Chebyshev UCL	4.819	99% KM Chebyshev UCL	6.778

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.394	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.088	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	9.577	nu star (bias corrected)	N/A
Mean (detects)	5		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.516	SD (KM)	1.587
Variance (KM)	2.518	SE of Mean (KM)	0.529
k hat (KM)	0.912	k star (KM)	0.797
nu hat (KM)	32.84	nu star (KM)	28.7
theta hat (KM)	1.661	theta star (KM)	1.901
80% gamma percentile (KM)	2.477	90% gamma percentile (KM)	3.688
95% gamma percentile (KM)	4.922	99% gamma percentile (KM)	7.838

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0357
Approximate Chi Square Value (28.70, α)	17.48	Adjusted Chi Square Value (28.70, β)	16.64
95% Gamma Approximate KM-UCL (use when n>=50)	2.489	95% Gamma Adjusted KM-UCL (use when n<50)	2.615

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.564	Mean in Log Scale	-5.024
SD in Original Scale	1.914	SD in Log Scale	2.852
95% t UCL (assumes normality of ROS data)	1.349	95% Percentile Bootstrap UCL	1.446
95% BCA Bootstrap UCL	1.9	95% Bootstrap t UCL	65.54
95% H-UCL (Log ROS)	22.71		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.222	KM Geo Mean	1.249
KM SD (logged)	0.472	95% Critical H Value (KM-Log)	1.995
KM Standard Error of Mean (logged)	0.157	95% H-UCL (KM -Log)	1.754
KM SD (logged)	0.472	95% Critical H Value (KM-Log)	1.995
KM Standard Error of Mean (logged)	0.157		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.159	Mean in Log Scale	-0.202
SD in Original Scale	1.739	SD in Log Scale	0.643
95% t UCL (Assumes normality)	1.872	95% H-Stat UCL	1.409

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	3.821

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	16
Number of Detects	12	Number of Non-Detects	4
Number of Distinct Detects	12	Number of Distinct Non-Detects	4
Minimum Detect	9.8	Minimum Non-Detect	5.7
Maximum Detect	61.4	Maximum Non-Detect	8.4
Variance Detects	298.8	Percent Non-Detects	25%
Mean Detects	31.11	SD Detects	17.29
Median Detects	30.35	CV Detects	0.556
Skewness Detects	0.318	Kurtosis Detects	-1.077
Mean of Logged Detects	3.269	SD of Logged Detects	0.639

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.94	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.124	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	24.76	KM Standard Error of Mean	4.718
KM SD	18.07	95% KM (BCA) UCL	32.19
95% KM (t) UCL	33.03	95% KM (Percentile Bootstrap) UCL	33.02
95% KM (z) UCL	32.52	95% KM Bootstrap t UCL	33.93
90% KM Chebyshev UCL	38.91	95% KM Chebyshev UCL	45.32
97.5% KM Chebyshev UCL	54.22	99% KM Chebyshev UCL	71.7

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.322	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.158	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.247	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.116	k star (bias corrected MLE)	2.393
Theta hat (MLE)	9.982	Theta star (bias corrected MLE)	13
nu hat (MLE)	74.8	nu star (bias corrected)	57.43
Mean (detects)	31.11		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.541	Mean	23.47
Maximum	61.4	Median	20.35
SD	20.15	CV	0.859
k hat (MLE)	0.704	k star (bias corrected MLE)	0.614
Theta hat (MLE)	33.33	Theta star (bias corrected MLE)	38.23
nu hat (MLE)	22.53	nu star (bias corrected)	19.64
Adjusted Level of Significance (β)	0.0335		
Approximate Chi Square Value (19.64, α)	10.59	Adjusted Chi Square Value (19.64, β)	9.836
95% Gamma Approximate UCL (use when n>=50)	43.54	95% Gamma Adjusted UCL (use when n<50)	46.86

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	24.76	SD (KM)	18.07
Variance (KM)	326.5	SE of Mean (KM)	4.718
k hat (KM)	1.877	k star (KM)	1.567
nu hat (KM)	60.07	nu star (KM)	50.14
theta hat (KM)	13.19	theta star (KM)	15.8
80% gamma percentile (KM)	38.12	90% gamma percentile (KM)	51.04
95% gamma percentile (KM)	63.56	99% gamma percentile (KM)	91.74

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (50.14, α)	34.88	Adjusted Chi Square Value (50.14, β)	33.44
95% Gamma Approximate KM-UCL (use when n>=50)	35.59	95% Gamma Adjusted KM-UCL (use when n<50)	37.12

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	24.83	Mean in Log Scale	2.9
SD in Original Scale	18.58	SD in Log Scale	0.857
95% t UCL (assumes normality of ROS data)	32.98	95% Percentile Bootstrap UCL	32.54
95% BCA Bootstrap UCL	33	95% Bootstrap t UCL	33.8
95% H-UCL (Log ROS)	45.55		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.887	KM Geo Mean	17.93
KM SD (logged)	0.848	95% Critical H Value (KM-Log)	2.479
KM Standard Error of Mean (logged)	0.221	95% H-UCL (KM -Log)	44.19
KM SD (logged)	0.848	95% Critical H Value (KM-Log)	2.479
KM Standard Error of Mean (logged)	0.221		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	24.19	Mean in Log Scale	2.756
SD in Original Scale	19.3	SD in Log Scale	1.07
95% t UCL (Assumes normality)	32.64	95% H-Stat UCL	60.7

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 33.03

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	20.6	Mean	6221
Maximum	88400	Median	1230
SD	18899	Std. Error of Mean	4029
Coefficient of Variation	3.038	Skewness	4.313

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.335	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.444	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	13154	95% Adjusted-CLT UCL (Chen-1995)	16807
		95% Modified-t UCL (Johnson-1978)	13772

Gamma GOF Test

A-D Test Statistic	2.674	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.827	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.351	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.199	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.397	k star (bias corrected MLE)	0.373
Theta hat (MLE)	15667	Theta star (bias corrected MLE)	16667
nu hat (MLE)	17.47	nu star (bias corrected)	16.42
MLE Mean (bias corrected)	6221	MLE Sd (bias corrected)	10183
		Approximate Chi Square Value (0.05)	8.261
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	7.83

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	12367	95% Adjusted Gamma UCL (use when n<50)	13047

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.025	Mean of logged Data	7.077
Maximum of Logged Data	11.39	SD of logged Data	1.652

Assuming Lognormal Distribution

95% H-UCL	16896	90% Chebyshev (MVUE) UCL	9385
95% Chebyshev (MVUE) UCL	11789	97.5% Chebyshev (MVUE) UCL	15125
99% Chebyshev (MVUE) UCL	21678		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 10. ProUCL Output - Beaver Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	12848	95% Jackknife UCL	13154
95% Standard Bootstrap UCL	12644	95% Bootstrap-t UCL	76170
95% Hall's Bootstrap UCL	52777	95% Percentile Bootstrap UCL	13313
95% BCA Bootstrap UCL	18792		
90% Chebyshev(Mean, Sd) UCL	18309	95% Chebyshev(Mean, Sd) UCL	23784
97.5% Chebyshev(Mean, Sd) UCL	31383	99% Chebyshev(Mean, Sd) UCL	46311

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 23784

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:15:41 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	37
		Number of Missing Observations	0
Minimum	1280	Mean	5315
Maximum	14700	Median	4340
SD	3329	Std. Error of Mean	547.3
Coefficient of Variation	0.626	Skewness	1.056

Normal GOF Test

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.169	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6239	95% Adjusted-CLT UCL (Chen-1995)	6317
		95% Modified-t UCL (Johnson-1978)	6255

Gamma GOF Test

A-D Test Statistic	0.372	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0956	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.146	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.8	k star (bias corrected MLE)	2.591
Theta hat (MLE)	1899	Theta star (bias corrected MLE)	2052
nu hat (MLE)	207.2	nu star (bias corrected)	191.7
MLE Mean (bias corrected)	5315	MLE Sd (bias corrected)	3302
		Approximate Chi Square Value (0.05)	160.7
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	159.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	6342	95% Adjusted Gamma UCL (use when n<50)	6391

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0798	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.144	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.155	Mean of logged Data	8.389
Maximum of Logged Data	9.596	SD of logged Data	0.635

Assuming Lognormal Distribution

95% H-UCL	6667	90% Chebyshev (MVUE) UCL	7146
95% Chebyshev (MVUE) UCL	7961	97.5% Chebyshev (MVUE) UCL	9091
99% Chebyshev (MVUE) UCL	11312		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6215	95% Jackknife UCL	6239
95% Standard Bootstrap UCL	6212	95% Bootstrap-t UCL	6388
95% Hall's Bootstrap UCL	6329	95% Percentile Bootstrap UCL	6246
95% BCA Bootstrap UCL	6349		
90% Chebyshev(Mean, Sd) UCL	6957	95% Chebyshev(Mean, Sd) UCL	7701
97.5% Chebyshev(Mean, Sd) UCL	8733	99% Chebyshev(Mean, Sd) UCL	10761

Suggested UCL to Use

95% Adjusted Gamma UCL 6391

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	30
Number of Detects	7	Number of Non-Detects	30
Number of Distinct Detects	5	Number of Distinct Non-Detects	27
Minimum Detect	0.6	Minimum Non-Detect	0.5
Maximum Detect	7.1	Maximum Non-Detect	30.8
Variance Detects	5.693	Percent Non-Detects	81.08%
Mean Detects	1.7	SD Detects	2.386
Median Detects	0.8	CV Detects	1.404
Skewness Detects	2.623	Kurtosis Detects	6.908
Mean of Logged Detects	0.0733	SD of Logged Detects	0.853

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.513	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.473	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.204	KM Standard Error of Mean	0.557
KM SD	1.786	95% KM (BCA) UCL	2.367
95% KM (t) UCL	2.145	95% KM (Percentile Bootstrap) UCL	2.161
95% KM (z) UCL	2.12	95% KM Bootstrap t UCL	8.355
90% KM Chebyshev UCL	2.875	95% KM Chebyshev UCL	3.632
97.5% KM Chebyshev UCL	4.683	99% KM Chebyshev UCL	6.747

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.464	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.725	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.447	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.318	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.233	k star (bias corrected MLE)	0.8
Theta hat (MLE)	1.379	Theta star (bias corrected MLE)	2.125
nu hat (MLE)	17.26	nu star (bias corrected)	11.2
Mean (detects)	1.7		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.354
Maximum	7.1	Median	0.01
SD	1.185	CV	3.352
k hat (MLE)	0.274	k star (bias corrected MLE)	0.269
Theta hat (MLE)	1.293	Theta star (bias corrected MLE)	1.312
nu hat (MLE)	20.24	nu star (bias corrected)	19.93
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (19.93, α)	10.8	Adjusted Chi Square Value (19.93, β)	10.51
95% Gamma Approximate UCL (use when n>=50)	0.652	95% Gamma Adjusted UCL (use when n<50)	0.671

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.204	SD (KM)	1.786
Variance (KM)	3.191	SE of Mean (KM)	0.557
k hat (KM)	0.454	k star (KM)	0.436
nu hat (KM)	33.62	nu star (KM)	32.23
theta hat (KM)	2.65	theta star (KM)	2.765
80% gamma percentile (KM)	1.96	90% gamma percentile (KM)	3.349
95% gamma percentile (KM)	4.857	99% gamma percentile (KM)	8.617

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (32.23, α)	20.26	Adjusted Chi Square Value (32.23, β)	19.84
95% Gamma Approximate KM-UCL (use when n>=50)	1.916	95% Gamma Adjusted KM-UCL (use when n<50)	1.956

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.66	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.391	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.682	Mean in Log Scale	-0.704
SD in Original Scale	1.102	SD in Log Scale	0.652
95% t UCL (assumes normality of ROS data)	0.988	95% Percentile Bootstrap UCL	1.036
95% BCA Bootstrap UCL	1.239	95% Bootstrap t UCL	2.034
95% H-UCL (Log ROS)	0.763		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.238	KM Geo Mean	0.788
KM SD (logged)	0.708	95% Critical H Value (KM-Log)	2.087
KM Standard Error of Mean (logged)	0.221	95% H-UCL (KM -Log)	1.295
KM SD (logged)	0.708	95% Critical H Value (KM-Log)	2.087
KM Standard Error of Mean (logged)	0.221		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.684	Mean in Log Scale	0.89
SD in Original Scale	2.795	SD in Log Scale	1.103
95% t UCL (Assumes normality)	4.46	95% H-Stat UCL	7.097

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 3.632

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	37
Number of Detects	28	Number of Non-Detects	9
Number of Distinct Detects	28	Number of Distinct Non-Detects	9

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	1.8	Minimum Non-Detect	1.29
Maximum Detect	8.6	Maximum Non-Detect	5.13
Variance Detects	4.662	Percent Non-Detects	24.32%
Mean Detects	4.677	SD Detects	2.159
Median Detects	4.02	CV Detects	0.462
Skewness Detects	0.574	Kurtosis Detects	-1.02
Mean of Logged Detects	1.438	SD of Logged Detects	0.47

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.897	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.163	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	3.96	KM Standard Error of Mean	0.385
KM SD	2.276	95% KM (BCA) UCL	4.568
95% KM (t) UCL	4.609	95% KM (Percentile Bootstrap) UCL	4.595
95% KM (z) UCL	4.592	95% KM Bootstrap t UCL	4.632
90% KM Chebyshev UCL	5.113	95% KM Chebyshev UCL	5.636
97.5% KM Chebyshev UCL	6.361	99% KM Chebyshev UCL	7.786

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.574	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.749	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.132	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.166	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.951	k star (bias corrected MLE)	4.444
Theta hat (MLE)	0.945	Theta star (bias corrected MLE)	1.052
nu hat (MLE)	277.3	nu star (bias corrected)	248.9
Mean (detects)	4.677		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.974	Mean	3.911
Maximum	8.6	Median	3.33
SD	2.348	CV	0.6
k hat (MLE)	2.67	k star (bias corrected MLE)	2.471
Theta hat (MLE)	1.465	Theta star (bias corrected MLE)	1.583
nu hat (MLE)	197.5	nu star (bias corrected)	182.9
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (182.86, α)	152.6	Adjusted Chi Square Value (182.86, β)	151.4
95% Gamma Approximate UCL (use when n>=50)	4.688	95% Gamma Adjusted UCL (use when n<50)	4.725

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	3.96	SD (KM)	2.276
Variance (KM)	5.18	SE of Mean (KM)	0.385
k hat (KM)	3.027	k star (KM)	2.799
nu hat (KM)	224	nu star (KM)	207.2
theta hat (KM)	1.308	theta star (KM)	1.414
80% gamma percentile (KM)	5.695	90% gamma percentile (KM)	7.132
95% gamma percentile (KM)	8.478	99% gamma percentile (KM)	11.41

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (207.15, α)	174.8	Adjusted Chi Square Value (207.15, β)	173.6
95% Gamma Approximate KM-UCL (use when n>=50)	4.691	95% Gamma Adjusted KM-UCL (use when n<50)	4.726

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.123	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.995	Mean in Log Scale	1.232
SD in Original Scale	2.248	SD in Log Scale	0.564
95% t UCL (assumes normality of ROS data)	4.619	95% Percentile Bootstrap UCL	4.603
95% BCA Bootstrap UCL	4.657	95% Bootstrap t UCL	4.676
95% H-UCL (Log ROS)	4.835		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.201	KM Geo Mean	3.322
KM SD (logged)	0.61	95% Critical H Value (KM-Log)	1.999
KM Standard Error of Mean (logged)	0.104	95% H-UCL (KM -Log)	4.902
KM SD (logged)	0.61	95% Critical H Value (KM-Log)	1.999
KM Standard Error of Mean (logged)	0.104		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.843	Mean in Log Scale	1.109
SD in Original Scale	2.416	SD in Log Scale	0.758
95% t UCL (Assumes normality)	4.513	95% H-Stat UCL	5.291

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 4.609

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	35
Number of Detects	36	Number of Non-Detects	1
Number of Distinct Detects	35	Number of Distinct Non-Detects	1
Minimum Detect	26.9	Minimum Non-Detect	26.9
Maximum Detect	181	Maximum Non-Detect	26.9
Variance Detects	1362	Percent Non-Detects	2.703%
Mean Detects	78.12	SD Detects	36.9
Median Detects	81.3	CV Detects	0.472
Skewness Detects	0.868	Kurtosis Detects	0.857
Mean of Logged Detects	4.246	SD of Logged Detects	0.493

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.935	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.127	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.145	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	76.74	KM Standard Error of Mean	6.142
KM SD	36.84	95% KM (BCA) UCL	86.85
95% KM (t) UCL	87.11	95% KM (Percentile Bootstrap) UCL	87.22
95% KM (z) UCL	86.84	95% KM Bootstrap t UCL	87.65
90% KM Chebyshev UCL	95.16	95% KM Chebyshev UCL	103.5
97.5% KM Chebyshev UCL	115.1	99% KM Chebyshev UCL	137.9

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.416	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.117	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.147	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.632	k star (bias corrected MLE)	4.264
Theta hat (MLE)	16.87	Theta star (bias corrected MLE)	18.32
nu hat (MLE)	333.5	nu star (bias corrected)	307
Mean (detects)	78.12		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	12.26	Mean	76.34
Maximum	181	Median	80.7
SD	37.96	CV	0.497
k hat (MLE)	3.841	k star (bias corrected MLE)	3.548
Theta hat (MLE)	19.88	Theta star (bias corrected MLE)	21.52
nu hat (MLE)	284.2	nu star (bias corrected)	262.5
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (262.52, α)	226	Adjusted Chi Square Value (262.52, β)	224.5
95% Gamma Approximate UCL (use when n>=50)	88.68	95% Gamma Adjusted UCL (use when n<50)	89.26

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	76.74	SD (KM)	36.84
Variance (KM)	1357	SE of Mean (KM)	6.142
k hat (KM)	4.339	k star (KM)	4.005
nu hat (KM)	321.1	nu star (KM)	296.4
theta hat (KM)	17.69	theta star (KM)	19.16
80% gamma percentile (KM)	105.8	90% gamma percentile (KM)	128.1
95% gamma percentile (KM)	148.7	99% gamma percentile (KM)	192.6

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (296.39, α)	257.5	Adjusted Chi Square Value (296.39, β)	255.9
95% Gamma Approximate KM-UCL (use when n>=50)	88.32	95% Gamma Adjusted KM-UCL (use when n<50)	88.86

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.935	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.145	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	76.55	Mean in Log Scale	4.213
SD in Original Scale	37.62	SD in Log Scale	0.527
95% t UCL (assumes normality of ROS data)	86.99	95% Percentile Bootstrap UCL	86.79
95% BCA Bootstrap UCL	88.18	95% Bootstrap t UCL	89.02
95% H-UCL (Log ROS)	91.98		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.221	KM Geo Mean	68.08
KM SD (logged)	0.503	95% Critical H Value (KM-Log)	1.915
KM Standard Error of Mean (logged)	0.0839	95% H-UCL (KM -Log)	90.75
KM SD (logged)	0.503	95% Critical H Value (KM-Log)	1.915
KM Standard Error of Mean (logged)	0.0839		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	76.37	Mean in Log Scale	4.202
SD in Original Scale	37.91	SD in Log Scale	0.556
95% t UCL (Assumes normality)	86.9	95% H-Stat UCL	93.49

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use
95% KM (t) UCL 87.11

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	30
Number of Detects	15	Number of Non-Detects	22
Number of Distinct Detects	9	Number of Distinct Non-Detects	21
Minimum Detect	0.7	Minimum Non-Detect	0.599
Maximum Detect	1.4	Maximum Non-Detect	2.57
Variance Detects	0.0317	Percent Non-Detects	59.46%
Mean Detects	0.892	SD Detects	0.178
Median Detects	0.815	CV Detects	0.2
Skewness Detects	1.864	Kurtosis Detects	4.114
Mean of Logged Detects	-0.13	SD of Logged Detects	0.178

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.802	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.282	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.741	KM Standard Error of Mean	0.0323
KM SD	0.178	95% KM (BCA) UCL	0.804
95% KM (t) UCL	0.796	95% KM (Percentile Bootstrap) UCL	0.801
95% KM (z) UCL	0.794	95% KM Bootstrap t UCL	0.799
90% KM Chebyshev UCL	0.838	95% KM Chebyshev UCL	0.882
97.5% KM Chebyshev UCL	0.943	99% KM Chebyshev UCL	1.063

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.924	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.735	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.256	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.221	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	31.54	k star (bias corrected MLE)	25.27
Theta hat (MLE)	0.0283	Theta star (bias corrected MLE)	0.0353
nu hat (MLE)	946.1	nu star (bias corrected)	758.2
Mean (detects)	0.892		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.44	Mean	0.694
Maximum	1.4	Median	0.646
SD	0.205	CV	0.296
k hat (MLE)	13.63	k star (bias corrected MLE)	12.54
Theta hat (MLE)	0.0509	Theta star (bias corrected MLE)	0.0553
nu hat (MLE)	1009	nu star (bias corrected)	928.2
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (928.15, α)	858.4	Adjusted Chi Square Value (928.15, β)	855.5
95% Gamma Approximate UCL (use when n>=50)	0.75	95% Gamma Adjusted UCL (use when n<50)	0.753

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.741	SD (KM)	0.178
Variance (KM)	0.0318	SE of Mean (KM)	0.0323
k hat (KM)	17.27	k star (KM)	15.89
nu hat (KM)	1278	nu star (KM)	1176
theta hat (KM)	0.0429	theta star (KM)	0.0466
80% gamma percentile (KM)	0.891	90% gamma percentile (KM)	0.987
95% gamma percentile (KM)	1.071	99% gamma percentile (KM)	1.241

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1097	Adjusted Chi Square Value (N/A, β)	1094
95% Gamma Approximate KM-UCL (use when n>=50)	0.794	95% Gamma Adjusted KM-UCL (use when n<50)	0.797

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.723	Mean in Log Scale	-0.35
SD in Original Scale	0.183	SD in Log Scale	0.223
95% t UCL (assumes normality of ROS data)	0.774	95% Percentile Bootstrap UCL	0.775
95% BCA Bootstrap UCL	0.778	95% Bootstrap t UCL	0.787
95% H-UCL (Log ROS)	0.771		

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.324	KM Geo Mean	0.723
KM SD (logged)	0.214	95% Critical H Value (KM-Log)	1.742
KM Standard Error of Mean (logged)	0.0396	95% H-UCL (KM -Log)	0.787
KM SD (logged)	0.214	95% Critical H Value (KM-Log)	1.742
KM Standard Error of Mean (logged)	0.0396		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.611	Mean in Log Scale	-0.604
SD in Original Scale	0.302	SD in Log Scale	0.471
95% t UCL (Assumes normality)	0.695	95% H-Stat UCL	0.708

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.796	KM H-UCL	0.787
95% KM (BCA) UCL	0.804		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	32
Number of Detects	19	Number of Non-Detects	18
Number of Distinct Detects	18	Number of Distinct Non-Detects	14
Minimum Detect	0.8	Minimum Non-Detect	0.07
Maximum Detect	37.5	Maximum Non-Detect	2.57
Variance Detects	106.7	Percent Non-Detects	48.65%
Mean Detects	5.712	SD Detects	10.33
Median Detects	2.44	CV Detects	1.809
Skewness Detects	2.74	Kurtosis Detects	6.521
Mean of Logged Detects	0.94	SD of Logged Detects	1.106

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.493	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.386	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.989	KM Standard Error of Mean	1.306
KM SD	7.732	95% KM (BCA) UCL	5.154
95% KM (t) UCL	5.194	95% KM (Percentile Bootstrap) UCL	5.289
95% KM (z) UCL	5.137	95% KM Bootstrap t UCL	13.31
90% KM Chebyshev UCL	6.907	95% KM Chebyshev UCL	8.682
97.5% KM Chebyshev UCL	11.15	99% KM Chebyshev UCL	15.98

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.125	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.779	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.245	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.206	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.746	k star (bias corrected MLE)	0.664
Theta hat (MLE)	7.655	Theta star (bias corrected MLE)	8.609
nu hat (MLE)	28.36	nu star (bias corrected)	25.21
Mean (detects)	5.712		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.938
Maximum	37.5	Median	0.8
SD	7.856	CV	2.674
k hat (MLE)	0.25	k star (bias corrected MLE)	0.248
Theta hat (MLE)	11.73	Theta star (bias corrected MLE)	11.84
nu hat (MLE)	18.53	nu star (bias corrected)	18.36
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (18.36, α)	9.653	Adjusted Chi Square Value (18.36, β)	9.379
95% Gamma Approximate UCL (use when n>=50)	5.589	95% Gamma Adjusted UCL (use when n<50)	5.753

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.989	SD (KM)	7.732
Variance (KM)	59.78	SE of Mean (KM)	1.306
k hat (KM)	0.149	k star (KM)	0.155
nu hat (KM)	11.06	nu star (KM)	11.5
theta hat (KM)	20	theta star (KM)	19.24
80% gamma percentile (KM)	3.346	90% gamma percentile (KM)	8.904
95% gamma percentile (KM)	16.34	99% gamma percentile (KM)	37.75

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (11.50, α)	4.897	Adjusted Chi Square Value (11.50, β)	4.711
95% Gamma Approximate KM-UCL (use when n>=50)	7.017	95% Gamma Adjusted KM-UCL (use when n<50)	7.295

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.844	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.027	Mean in Log Scale	-0.364
SD in Original Scale	7.823	SD in Log Scale	1.598
95% t UCL (assumes normality of ROS data)	5.198	95% Percentile Bootstrap UCL	5.291
95% BCA Bootstrap UCL	6.234	95% Bootstrap t UCL	13.87
95% H-UCL (Log ROS)	5.771		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.754	KM Geo Mean	0.47
KM SD (logged)	1.942	95% Critical H Value (KM-Log)	3.645
KM Standard Error of Mean (logged)	0.333	95% H-UCL (KM -Log)	10.09
KM SD (logged)	1.942	95% Critical H Value (KM-Log)	3.645
KM Standard Error of Mean (logged)	0.333		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.084	Mean in Log Scale	-0.336
SD in Original Scale	7.804	SD in Log Scale	1.741
95% t UCL (Assumes normality)	5.25	95% H-Stat UCL	8.615

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 10.09

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	37
		Number of Missing Observations	0
Minimum	7.4	Mean	27.25
Maximum	84.7	Median	21
SD	18.23	Std. Error of Mean	2.997
Coefficient of Variation	0.669	Skewness	1.147

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.883	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	32.31	95% Adjusted-CLT UCL (Chen-1995)	32.78
		95% Modified-t UCL (Johnson-1978)	32.4

Gamma GOF Test

A-D Test Statistic	0.585	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.108	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.146	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.497	k star (bias corrected MLE)	2.313
Theta hat (MLE)	10.91	Theta star (bias corrected MLE)	11.78
nu hat (MLE)	184.8	nu star (bias corrected)	171.1
MLE Mean (bias corrected)	27.25	MLE Sd (bias corrected)	17.92
		Approximate Chi Square Value (0.05)	141.9
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	140.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	32.87	95% Adjusted Gamma UCL (use when n<50)	33.14

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.106	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.144	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.001	Mean of logged Data	3.092
Maximum of Logged Data	4.439	SD of logged Data	0.67

Assuming Lognormal Distribution

95% H-UCL	34.67	90% Chebyshev (MVUE) UCL	37.14
95% Chebyshev (MVUE) UCL	41.57	97.5% Chebyshev (MVUE) UCL	47.72
99% Chebyshev (MVUE) UCL	59.8		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	32.18	95% Jackknife UCL	32.31
95% Standard Bootstrap UCL	32.07	95% Bootstrap-t UCL	33.08
95% Hall's Bootstrap UCL	32.65	95% Percentile Bootstrap UCL	32.23
95% BCA Bootstrap UCL	32.79		
90% Chebyshev(Mean, Sd) UCL	36.24	95% Chebyshev(Mean, Sd) UCL	40.31
97.5% Chebyshev(Mean, Sd) UCL	45.96	99% Chebyshev(Mean, Sd) UCL	57.07

Suggested UCL to Use

95% Adjusted Gamma UCL 33.14

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	37
Number of Detects	21	Number of Non-Detects	16
Number of Distinct Detects	21	Number of Distinct Non-Detects	16
Minimum Detect	5.2	Minimum Non-Detect	6.44
Maximum Detect	13.3	Maximum Non-Detect	25.7
Variance Detects	4.29	Percent Non-Detects	43.24%
Mean Detects	8.433	SD Detects	2.071
Median Detects	7.78	CV Detects	0.246
Skewness Detects	0.754	Kurtosis Detects	0.209
Mean of Logged Detects	2.105	SD of Logged Detects	0.239

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.182	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.528	KM Standard Error of Mean	0.357
KM SD	1.965	95% KM (BCA) UCL	8.145
95% KM (t) UCL	8.13	95% KM (Percentile Bootstrap) UCL	8.14
95% KM (z) UCL	8.115	95% KM Bootstrap t UCL	8.199
90% KM Chebyshev UCL	8.598	95% KM Chebyshev UCL	9.083
97.5% KM Chebyshev UCL	9.755	99% KM Chebyshev UCL	11.08

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.269	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.16	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.189	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	18.33	k star (bias corrected MLE)	15.74
Theta hat (MLE)	0.46	Theta star (bias corrected MLE)	0.536
nu hat (MLE)	769.9	nu star (bias corrected)	661.2
Mean (detects)	8.433		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.2	Mean	7.438
Maximum	13.3	Median	6.91
SD	1.97	CV	0.265
k hat (MLE)	16.84	k star (bias corrected MLE)	15.5
Theta hat (MLE)	0.442	Theta star (bias corrected MLE)	0.48
nu hat (MLE)	1246	nu star (bias corrected)	1147
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (N/A, α)	1069	Adjusted Chi Square Value (N/A, β)	1066
95% Gamma Approximate UCL (use when n>=50)	7.978	95% Gamma Adjusted UCL (use when n<50)	8.003

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.528	SD (KM)	1.965
Variance (KM)	3.862	SE of Mean (KM)	0.357
k hat (KM)	14.67	k star (KM)	13.5
nu hat (KM)	1086	nu star (KM)	999.2
theta hat (KM)	0.513	theta star (KM)	0.558
80% gamma percentile (KM)	9.177	90% gamma percentile (KM)	10.24
95% gamma percentile (KM)	11.18	99% gamma percentile (KM)	13.09

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (999.16, α)	926.8	Adjusted Chi Square Value (999.16, β)	923.8
95% Gamma Approximate KM-UCL (use when n>=50)	8.116	95% Gamma Adjusted KM-UCL (use when n<50)	8.143

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.983	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.145	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.497	Mean in Log Scale	1.987
SD in Original Scale	1.919	SD in Log Scale	0.231
95% t UCL (assumes normality of ROS data)	8.029	95% Percentile Bootstrap UCL	8.005
95% BCA Bootstrap UCL	8.077	95% Bootstrap t UCL	8.111
95% H-UCL (Log ROS)	8.012		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.988	KM Geo Mean	7.301
KM SD (logged)	0.242	95% Critical H Value (KM-Log)	1.755
KM Standard Error of Mean (logged)	0.0457	95% H-UCL (KM -Log)	8.07
KM SD (logged)	0.242	95% Critical H Value (KM-Log)	1.755
KM Standard Error of Mean (logged)	0.0457		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	6.711	Mean in Log Scale	1.811
SD in Original Scale	2.93	SD in Log Scale	0.439
95% t UCL (Assumes normality)	7.524	95% H-Stat UCL	7.724

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 8.13

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	36
Number of Detects	34	Number of Non-Detects	3
Number of Distinct Detects	33	Number of Distinct Non-Detects	3
Minimum Detect	0.7	Minimum Non-Detect	3
Maximum Detect	13.8	Maximum Non-Detect	3.22
Variance Detects	7.798	Percent Non-Detects	8.108%
Mean Detects	6.276	SD Detects	2.793
Median Detects	6.43	CV Detects	0.445
Skewness Detects	0.332	Kurtosis Detects	1.014
Mean of Logged Detects	1.694	SD of Logged Detects	0.638

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.933	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0918	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.15	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.854	KM Standard Error of Mean	0.501
KM SD	2.999	95% KM (BCA) UCL	6.739
95% KM (t) UCL	6.7	95% KM (Percentile Bootstrap) UCL	6.718
95% KM (z) UCL	6.678	95% KM Bootstrap t UCL	6.696
90% KM Chebyshev UCL	7.358	95% KM Chebyshev UCL	8.039
97.5% KM Chebyshev UCL	8.984	99% KM Chebyshev UCL	10.84

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.178	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.158	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.152	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.653	k star (bias corrected MLE)	3.35
Theta hat (MLE)	1.718	Theta star (bias corrected MLE)	1.873
nu hat (MLE)	248.4	nu star (bias corrected)	227.8
Mean (detects)	6.276		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.7	Mean	5.962
Maximum	13.8	Median	6.22
SD	2.88	CV	0.483
k hat (MLE)	3.324	k star (bias corrected MLE)	3.072
Theta hat (MLE)	1.794	Theta star (bias corrected MLE)	1.941
nu hat (MLE)	246	nu star (bias corrected)	227.4
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (227.35, α)	193.5	Adjusted Chi Square Value (227.35, β)	192.1
95% Gamma Approximate UCL (use when n>=50)	7.007	95% Gamma Adjusted UCL (use when n<50)	7.056

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.854	SD (KM)	2.999
Variance (KM)	8.993	SE of Mean (KM)	0.501
k hat (KM)	3.81	k star (KM)	3.519
nu hat (KM)	281.9	nu star (KM)	260.4
theta hat (KM)	1.536	theta star (KM)	1.663
80% gamma percentile (KM)	8.192	90% gamma percentile (KM)	10.04
95% gamma percentile (KM)	11.75	99% gamma percentile (KM)	15.42

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (260.40, α)	224	Adjusted Chi Square Value (260.40, β)	222.6
95% Gamma Approximate KM-UCL (use when n>=50)	6.804	95% Gamma Adjusted KM-UCL (use when n<50)	6.848

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.809	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.15	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.928	Mean in Log Scale	1.612
SD in Original Scale	2.926	SD in Log Scale	0.672
95% t UCL (assumes normality of ROS data)	6.74	95% Percentile Bootstrap UCL	6.749
95% BCA Bootstrap UCL	6.701	95% Bootstrap t UCL	6.795
95% H-UCL (Log ROS)	7.903		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.555	KM Geo Mean	4.735
KM SD (logged)	0.77	95% Critical H Value (KM-Log)	2.146
KM Standard Error of Mean (logged)	0.131	95% H-UCL (KM -Log)	8.391
KM SD (logged)	0.77	95% Critical H Value (KM-Log)	2.146
KM Standard Error of Mean (logged)	0.131		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	5.893	Mean in Log Scale	1.592
SD in Original Scale	2.975	SD in Log Scale	0.702
95% t UCL (Assumes normality)	6.719	95% H-Stat UCL	8.023

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 6.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	35
		Number of Missing Observations	0
Minimum	5230	Mean	12668
Maximum	26900	Median	11700
SD	5831	Std. Error of Mean	958.6
Coefficient of Variation	0.46	Skewness	0.845

Normal GOF Test

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.109	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.144	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	14286	95% Adjusted-CLT UCL (Chen-1995)	14387
		95% Modified-t UCL (Johnson-1978)	14309

Gamma GOF Test

A-D Test Statistic	0.277	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.075	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.145	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.139	k star (bias corrected MLE)	4.74
Theta hat (MLE)	2465	Theta star (bias corrected MLE)	2672
nu hat (MLE)	380.3	nu star (bias corrected)	350.8
MLE Mean (bias corrected)	12668	MLE Sd (bias corrected)	5818
		Approximate Chi Square Value (0.05)	308.4
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	306.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	14410	95% Adjusted Gamma UCL (use when n<50)	14491

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0653	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.144	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.562	Mean of logged Data	9.346
Maximum of Logged Data	10.2	SD of logged Data	0.456

Assuming Lognormal Distribution

95% H-UCL	14667	90% Chebyshev (MVUE) UCL	15637
95% Chebyshev (MVUE) UCL	16980	97.5% Chebyshev (MVUE) UCL	18843
99% Chebyshev (MVUE) UCL	22502		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	14245	95% Jackknife UCL	14286
95% Standard Bootstrap UCL	14194	95% Bootstrap-t UCL	14445
95% Hall's Bootstrap UCL	14489	95% Percentile Bootstrap UCL	14259
95% BCA Bootstrap UCL	14323		
90% Chebyshev(Mean, Sd) UCL	15544	95% Chebyshev(Mean, Sd) UCL	16846
97.5% Chebyshev(Mean, Sd) UCL	18654	99% Chebyshev(Mean, Sd) UCL	22206

Suggested UCL to Use

95% Student's-t UCL 14286

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	36
		Number of Missing Observations	0
Minimum	7.61	Mean	124.2
Maximum	1520	Median	27.6
SD	330.7	Std. Error of Mean	54.36
Coefficient of Variation	2.661	Skewness	3.574

Normal GOF Test

Shapiro Wilk Test Statistic	0.363	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.455	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	216	95% Adjusted-CLT UCL (Chen-1995)	247.8
		95% Modified-t UCL (Johnson-1978)	221.3

Gamma GOF Test

A-D Test Statistic	6.977	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.811	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.367	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.153	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.516	k star (bias corrected MLE)	0.492
Theta hat (MLE)	240.9	Theta star (bias corrected MLE)	252.5
nu hat (MLE)	38.17	nu star (bias corrected)	36.41
MLE Mean (bias corrected)	124.2	MLE Sd (bias corrected)	177.1
		Approximate Chi Square Value (0.05)	23.6
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	23.15

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	191.7	95% Adjusted Gamma UCL (use when n<50)	195.4

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.749	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.243	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.144	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.029	Mean of logged Data	3.597
Maximum of Logged Data	7.326	SD of logged Data	1.163

Assuming Lognormal Distribution

95% H-UCL	118.4	90% Chebyshev (MVUE) UCL	117.9
95% Chebyshev (MVUE) UCL	139.7	97.5% Chebyshev (MVUE) UCL	170
99% Chebyshev (MVUE) UCL	229.5		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	213.7	95% Jackknife UCL	216
95% Standard Bootstrap UCL	212.7	95% Bootstrap-t UCL	336
95% Hall's Bootstrap UCL	226.1	95% Percentile Bootstrap UCL	219.7
95% BCA Bootstrap UCL	265		
90% Chebyshev(Mean, Sd) UCL	287.3	95% Chebyshev(Mean, Sd) UCL	361.2
97.5% Chebyshev(Mean, Sd) UCL	463.7	99% Chebyshev(Mean, Sd) UCL	665.1

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	361.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	37
		Number of Missing Observations	0
Minimum	77.3	Mean	689
Maximum	4770	Median	517
SD	781.6	Std. Error of Mean	128.5
Coefficient of Variation	1.134	Skewness	4.263

Normal GOF Test

Shapiro Wilk Test Statistic	0.556	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.29	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	905.9	95% Adjusted-CLT UCL (Chen-1995)	996.5
		95% Modified-t UCL (Johnson-1978)	920.9

Gamma GOF Test

A-D Test Statistic	1.084	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.764	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.147	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.679	k star (bias corrected MLE)	1.561
Theta hat (MLE)	410.2	Theta star (bias corrected MLE)	441.3
nu hat (MLE)	124.3	nu star (bias corrected)	115.5
MLE Mean (bias corrected)	689	MLE Sd (bias corrected)	551.4
		Approximate Chi Square Value (0.05)	91.72
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	90.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	867.9	95% Adjusted Gamma UCL (use when n<50)	876.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.147	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.144	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.348	Mean of logged Data	6.209
Maximum of Logged Data	8.47	SD of logged Data	0.795

Assuming Lognormal Distribution

95% H-UCL	908.9	90% Chebyshev (MVUE) UCL	967.6
95% Chebyshev (MVUE) UCL	1100	97.5% Chebyshev (MVUE) UCL	1285
99% Chebyshev (MVUE) UCL	1647		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	900.3	95% Jackknife UCL	905.9
95% Standard Bootstrap UCL	899.3	95% Bootstrap-t UCL	1166
95% Hall's Bootstrap UCL	1852	95% Percentile Bootstrap UCL	933.1
95% BCA Bootstrap UCL	1005		
90% Chebyshev(Mean, Sd) UCL	1074	95% Chebyshev(Mean, Sd) UCL	1249
97.5% Chebyshev(Mean, Sd) UCL	1491	99% Chebyshev(Mean, Sd) UCL	1967

Suggested UCL to Use

95% H-UCL	908.9

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Mercury (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	35
Number of Detects	17	Number of Non-Detects	20
Number of Distinct Detects	17	Number of Distinct Non-Detects	18
Minimum Detect	0.00497	Minimum Non-Detect	0.114
Maximum Detect	6.49	Maximum Non-Detect	0.518
Variance Detects	2.413	Percent Non-Detects	54.05%
Mean Detects	0.579	SD Detects	1.554
Median Detects	0.0464	CV Detects	2.684
Skewness Detects	3.87	Kurtosis Detects	15.45
Mean of Logged Detects	-2.541	SD of Logged Detects	2.035

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.402	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.356	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.284	KM Standard Error of Mean	0.179
KM SD	1.057	95% KM (BCA) UCL	0.643
95% KM (t) UCL	0.587	95% KM (Percentile Bootstrap) UCL	0.622
95% KM (z) UCL	0.579	95% KM Bootstrap t UCL	1.882
90% KM Chebyshev UCL	0.822	95% KM Chebyshev UCL	1.066
97.5% KM Chebyshev UCL	1.404	99% KM Chebyshev UCL	2.068

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.24	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.833	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.233	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.226	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.339	k star (bias corrected MLE)	0.318
Theta hat (MLE)	1.708	Theta star (bias corrected MLE)	1.818
nu hat (MLE)	11.52	nu star (bias corrected)	10.82
Mean (detects)	0.579		

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00497	Mean	0.271
Maximum	6.49	Median	0.01
SD	1.075	CV	3.961
k hat (MLE)	0.294	k star (bias corrected MLE)	0.288
Theta hat (MLE)	0.923	Theta star (bias corrected MLE)	0.941
nu hat (MLE)	21.76	nu star (bias corrected)	21.33
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (21.33, α)	11.84	Adjusted Chi Square Value (21.33, β)	11.53
95% Gamma Approximate UCL (use when n>=50)	0.489	95% Gamma Adjusted UCL (use when n<50)	0.502

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.284	SD (KM)	1.057
Variance (KM)	1.118	SE of Mean (KM)	0.179
k hat (KM)	0.0721	k star (KM)	0.0843
nu hat (KM)	5.336	nu star (KM)	6.237
theta hat (KM)	3.938	theta star (KM)	3.369
80% gamma percentile (KM)	0.149	90% gamma percentile (KM)	0.695
95% gamma percentile (KM)	1.654	99% gamma percentile (KM)	4.906

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (6.24, α)	1.762	Adjusted Chi Square Value (6.24, β)	1.661
95% Gamma Approximate KM-UCL (use when n>=50)	1.005	95% Gamma Adjusted KM-UCL (use when n<50)	1.066

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.158	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.207	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.281	Mean in Log Scale	-3.116
SD in Original Scale	1.072	SD in Log Scale	1.479
95% t UCL (assumes normality of ROS data)	0.579	95% Percentile Bootstrap UCL	0.616
95% BCA Bootstrap UCL	0.812	95% Bootstrap t UCL	1.902
95% H-UCL (Log ROS)	0.276		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.227	KM Geo Mean	0.0397
KM SD (logged)	1.63	95% Critical H Value (KM-Log)	3.197
KM Standard Error of Mean (logged)	0.336	95% H-UCL (KM -Log)	0.357
KM SD (logged)	1.63	95% Critical H Value (KM-Log)	3.197
KM Standard Error of Mean (logged)	0.336		

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.314	Mean in Log Scale	-2.525
SD in Original Scale	1.065	SD in Log Scale	1.383
95% t UCL (Assumes normality)	0.609	95% H-Stat UCL	0.403

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

97.5% KM (Chebyshev) UCL	1.404

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	36
Number of Detects	24	Number of Non-Detects	13
Number of Distinct Detects	23	Number of Distinct Non-Detects	13
Minimum Detect	5.22	Minimum Non-Detect	5.26
Maximum Detect	18.5	Maximum Non-Detect	20.5
Variance Detects	8.616	Percent Non-Detects	35.14%
Mean Detects	9.572	SD Detects	2.935
Median Detects	9.21	CV Detects	0.307
Skewness Detects	1.506	Kurtosis Detects	3.309
Mean of Logged Detects	2.219	SD of Logged Detects	0.282

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.875	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.168	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	8.327	KM Standard Error of Mean	0.527
KM SD	3.036	95% KM (BCA) UCL	9.176
95% KM (t) UCL	9.217	95% KM (Percentile Bootstrap) UCL	9.209
95% KM (z) UCL	9.194	95% KM Bootstrap t UCL	9.406
90% KM Chebyshev UCL	9.909	95% KM Chebyshev UCL	10.63
97.5% KM Chebyshev UCL	11.62	99% KM Chebyshev UCL	13.57

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.521	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.128	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	12.75	k star (bias corrected MLE)	11.18
Theta hat (MLE)	0.751	Theta star (bias corrected MLE)	0.856
nu hat (MLE)	612	nu star (bias corrected)	536.8
Mean (detects)	9.572		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.397	Mean	8.134
Maximum	18.5	Median	7.8
SD	3.159	CV	0.388
k hat (MLE)	7.621	k star (bias corrected MLE)	7.021
Theta hat (MLE)	1.067	Theta star (bias corrected MLE)	1.159
nu hat (MLE)	563.9	nu star (bias corrected)	519.5
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (519.54, α)	467.7	Adjusted Chi Square Value (519.54, β)	465.6
95% Gamma Approximate UCL (use when n>=50)	9.036	95% Gamma Adjusted UCL (use when n<50)	9.078

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	8.327	SD (KM)	3.036
Variance (KM)	9.217	SE of Mean (KM)	0.527
k hat (KM)	7.523	k star (KM)	6.931
nu hat (KM)	556.7	nu star (KM)	512.9
theta hat (KM)	1.107	theta star (KM)	1.201
80% gamma percentile (KM)	10.81	90% gamma percentile (KM)	12.55
95% gamma percentile (KM)	14.12	99% gamma percentile (KM)	17.39

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (512.87, α)	461.3	Adjusted Chi Square Value (512.87, β)	459.2
95% Gamma Approximate KM-UCL (use when n>=50)	9.256	95% Gamma Adjusted KM-UCL (use when n<50)	9.299

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.111	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	8.312	Mean in Log Scale	2.064
SD in Original Scale	2.974	SD in Log Scale	0.324
95% t UCL (assumes normality of ROS data)	9.138	95% Percentile Bootstrap UCL	9.112
95% BCA Bootstrap UCL	9.277	95% Bootstrap t UCL	9.348
95% H-UCL (Log ROS)	9.146		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.061	KM Geo Mean	7.851
KM SD (logged)	0.336	95% Critical H Value (KM-Log)	1.805
KM Standard Error of Mean (logged)	0.0591	95% H-UCL (KM -Log)	9.191
KM SD (logged)	0.336	95% Critical H Value (KM-Log)	1.805
KM Standard Error of Mean (logged)	0.0591		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	7.731	Mean in Log Scale	1.921
SD in Original Scale	3.697	SD in Log Scale	0.53
95% t UCL (Assumes normality)	8.757	95% H-Stat UCL	9.316

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 9.217

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	33
Number of Detects	7	Number of Non-Detects	30
Number of Distinct Detects	7	Number of Distinct Non-Detects	26
Minimum Detect	3.6	Minimum Non-Detect	1.5
Maximum Detect	9.2	Maximum Non-Detect	18
Variance Detects	4.248	Percent Non-Detects	81.08%
Mean Detects	5.506	SD Detects	2.061
Median Detects	4.8	CV Detects	0.374
Skewness Detects	1.232	Kurtosis Detects	0.339
Mean of Logged Detects	1.653	SD of Logged Detects	0.341

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.292	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.953	KM Standard Error of Mean	0.484
KM SD	1.87	95% KM (BCA) UCL	3.736
95% KM (t) UCL	3.77	95% KM (Percentile Bootstrap) UCL	3.76
95% KM (z) UCL	3.749	95% KM Bootstrap t UCL	3.628
90% KM Chebyshev UCL	4.405	95% KM Chebyshev UCL	5.062
97.5% KM Chebyshev UCL	5.975	99% KM Chebyshev UCL	7.768

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.498	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.709	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.264	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.312	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	9.577	k star (bias corrected MLE)	5.568
Theta hat (MLE)	0.575	Theta star (bias corrected MLE)	0.989
nu hat (MLE)	134.1	nu star (bias corrected)	77.95
Mean (detects)	5.506		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.591
Maximum	9.2	Median	2.207
SD	1.728	CV	0.667
k hat (MLE)	2.123	k star (bias corrected MLE)	1.969
Theta hat (MLE)	1.221	Theta star (bias corrected MLE)	1.316
nu hat (MLE)	157.1	nu star (bias corrected)	145.7
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (145.71, α)	118.8	Adjusted Chi Square Value (145.71, β)	117.8
95% Gamma Approximate UCL (use when n>=50)	3.178	95% Gamma Adjusted UCL (use when n<50)	3.206

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.953	SD (KM)	1.87
Variance (KM)	3.499	SE of Mean (KM)	0.484
k hat (KM)	2.492	k star (KM)	2.308
nu hat (KM)	184.4	nu star (KM)	170.8
theta hat (KM)	1.185	theta star (KM)	1.279
80% gamma percentile (KM)	4.346	90% gamma percentile (KM)	5.555
95% gamma percentile (KM)	6.698	99% gamma percentile (KM)	9.213

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (170.79, α)	141.6	Adjusted Chi Square Value (170.79, β)	140.4
95% Gamma Approximate KM-UCL (use when n>=50)	3.562	95% Gamma Adjusted KM-UCL (use when n<50)	3.592

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.897	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.204	Mean in Log Scale	1.102
SD in Original Scale	1.434	SD in Log Scale	0.327
95% t UCL (assumes normality of ROS data)	3.602	95% Percentile Bootstrap UCL	3.605
95% BCA Bootstrap UCL	3.74	95% Bootstrap t UCL	3.965
95% H-UCL (Log ROS)	3.501		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.908	KM Geo Mean	2.48
KM SD (logged)	0.575	95% Critical H Value (KM-Log)	1.971
KM Standard Error of Mean (logged)	0.17	95% H-UCL (KM -Log)	3.534
KM SD (logged)	0.575	95% Critical H Value (KM-Log)	1.971
KM Standard Error of Mean (logged)	0.17		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.09	Mean in Log Scale	0.959
SD in Original Scale	1.945	SD in Log Scale	0.604
95% t UCL (Assumes normality)	3.629	95% H-Stat UCL	3.826

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.77

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	24
Number of Detects	1	Number of Non-Detects	36
Number of Distinct Detects	1	Number of Distinct Non-Detects	23

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Silver (mg/kg) was not processed!

Thallium (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	29
Number of Detects	1	Number of Non-Detects	36
Number of Distinct Detects	1	Number of Distinct Non-Detects	28

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Thallium (mg/kg) was not processed!

Vanadium (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	36
		Number of Missing Observations	0
Minimum	9.1	Mean	25.51
Maximum	64.6	Median	25.1
SD	13.88	Std. Error of Mean	2.282
Coefficient of Variation	0.544	Skewness	1.058

Normal GOF Test

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.119	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.144	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	29.36	95% Adjusted-CLT UCL (Chen-1995)	29.69
		95% Modified-t UCL (Johnson-1978)	29.43

Gamma GOF Test

A-D Test Statistic	0.411	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.1	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.146	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	3.795	k star (bias corrected MLE)	3.505
Theta hat (MLE)	6.723	Theta star (bias corrected MLE)	7.278
nu hat (MLE)	280.8	nu star (bias corrected)	259.4
MLE Mean (bias corrected)	25.51	MLE Sd (bias corrected)	13.63
		Approximate Chi Square Value (0.05)	223.1
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	221.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	29.66	95% Adjusted Gamma UCL (use when n<50)	29.85

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.104	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.144	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.208	Mean of logged Data	3.102
Maximum of Logged Data	4.168	SD of logged Data	0.533

Assuming Lognormal Distribution

95% H-UCL	30.44	90% Chebyshev (MVUE) UCL	32.58
95% Chebyshev (MVUE) UCL	35.77	97.5% Chebyshev (MVUE) UCL	40.21
99% Chebyshev (MVUE) UCL	48.93		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	29.26	95% Jackknife UCL	29.36
95% Standard Bootstrap UCL	29.11	95% Bootstrap-t UCL	29.86
95% Hall's Bootstrap UCL	29.81	95% Percentile Bootstrap UCL	29.09
95% BCA Bootstrap UCL	29.56		
90% Chebyshev(Mean, Sd) UCL	32.35	95% Chebyshev(Mean, Sd) UCL	35.46
97.5% Chebyshev(Mean, Sd) UCL	39.76	99% Chebyshev(Mean, Sd) UCL	48.21

Suggested UCL to Use

95% Student's-t UCL 29.36

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Zinc (mg/kg)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	36
		Number of Missing Observations	0
Minimum	28.3	Mean	538
Maximum	4730	Median	189
SD	1048	Std. Error of Mean	172.2
Coefficient of Variation	1.947	Skewness	3.485

Normal GOF Test

Shapiro Wilk Test Statistic	0.475	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.313	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.144	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	828.7	95% Adjusted-CLT UCL (Chen-1995)	926.7
		95% Modified-t UCL (Johnson-1978)	845.2

Gamma GOF Test

A-D Test Statistic	2.372	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.795	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.224	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.151	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.682	k star (bias corrected MLE)	0.645
Theta hat (MLE)	788.8	Theta star (bias corrected MLE)	834.4
nu hat (MLE)	50.47	nu star (bias corrected)	47.71
MLE Mean (bias corrected)	538	MLE Sd (bias corrected)	670
		Approximate Chi Square Value (0.05)	32.86
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	32.32

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	781.1	95% Adjusted Gamma UCL (use when n<50)	794.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.124	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.144	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.343	Mean of logged Data	5.398
Maximum of Logged Data	8.462	SD of logged Data	1.223

Appendix D, Table 11. ProUCL Output - Lost Creek Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	802.6	90% Chebyshev (MVUE) UCL	784.1
95% Chebyshev (MVUE) UCL	934.8	97.5% Chebyshev (MVUE) UCL	1144
99% Chebyshev (MVUE) UCL	1554		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	821.3	95% Jackknife UCL	828.7
95% Standard Bootstrap UCL	817.2	95% Bootstrap-t UCL	1389
95% Hall's Bootstrap UCL	2051	95% Percentile Bootstrap UCL	841.5
95% BCA Bootstrap UCL	938.9		
90% Chebyshev(Mean, Sd) UCL	1055	95% Chebyshev(Mean, Sd) UCL	1289
97.5% Chebyshev(Mean, Sd) UCL	1614	99% Chebyshev(Mean, Sd) UCL	2252

Suggested UCL to Use

95% H-UCL 802.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:20:23 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	43
		Number of Missing Observations	0
Minimum	1140	Mean	6554
Maximum	19000	Median	5620
SD	4179	Std. Error of Mean	623
Coefficient of Variation	0.638	Skewness	1.085

Normal GOF Test

Shapiro Wilk Test Statistic	0.908	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7601	95% Adjusted-CLT UCL (Chen-1995)	7687
		95% Modified-t UCL (Johnson-1978)	7618

Gamma GOF Test

A-D Test Statistic	0.224	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0643	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.133	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.543	k star (bias corrected MLE)	2.388
Theta hat (MLE)	2578	Theta star (bias corrected MLE)	2745
nu hat (MLE)	228.9	nu star (bias corrected)	214.9
MLE Mean (bias corrected)	6554	MLE Sd (bias corrected)	4241
		Approximate Chi Square Value (0.05)	182
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	181

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7740	95% Adjusted Gamma UCL (use when n<50)	7783

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0738	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.131	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.039	Mean of logged Data	8.579
Maximum of Logged Data	9.852	SD of logged Data	0.683

Assuming Lognormal Distribution

95% H-UCL	8299	90% Chebyshev (MVUE) UCL	8891
95% Chebyshev (MVUE) UCL	9896	97.5% Chebyshev (MVUE) UCL	11290
99% Chebyshev (MVUE) UCL	14030		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7579	95% Jackknife UCL	7601
95% Standard Bootstrap UCL	7549	95% Bootstrap-t UCL	7692
95% Hall's Bootstrap UCL	7723	95% Percentile Bootstrap UCL	7533
95% BCA Bootstrap UCL	7674		
90% Chebyshev(Mean, Sd) UCL	8423	95% Chebyshev(Mean, Sd) UCL	9270
97.5% Chebyshev(Mean, Sd) UCL	10445	99% Chebyshev(Mean, Sd) UCL	12753

Suggested UCL to Use

95% Student's-t UCL 7601

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	39	Number of Distinct Observations	38
Number of Detects	5	Number of Non-Detects	34
Number of Distinct Detects	5	Number of Distinct Non-Detects	33
Minimum Detect	0.7	Minimum Non-Detect	0.5
Maximum Detect	3.2	Maximum Non-Detect	10.5
Variance Detects	1.228	Percent Non-Detects	87.18%
Mean Detects	1.94	SD Detects	1.108
Median Detects	1.6	CV Detects	0.571
Skewness Detects	0.257	Kurtosis Detects	-2.645
Mean of Logged Detects	0.511	SD of Logged Detects	0.639

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.231	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.306	KM Standard Error of Mean	0.382
KM SD	1.025	95% KM (BCA) UCL	1.956
95% KM (t) UCL	1.95	95% KM (Percentile Bootstrap) UCL	1.956
95% KM (z) UCL	1.934	95% KM Bootstrap t UCL	2.135
90% KM Chebyshev UCL	2.452	95% KM Chebyshev UCL	2.971
97.5% KM Chebyshev UCL	3.692	99% KM Chebyshev UCL	5.107

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.316	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.682	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.253	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.465	k star (bias corrected MLE)	1.519
Theta hat (MLE)	0.56	Theta star (bias corrected MLE)	1.277
nu hat (MLE)	34.65	nu star (bias corrected)	15.19
Mean (detects)	1.94		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.799
Maximum	3.2	Median	0.714
SD	0.61	CV	0.763
k hat (MLE)	1.273	k star (bias corrected MLE)	1.193
Theta hat (MLE)	0.627	Theta star (bias corrected MLE)	0.67
nu hat (MLE)	99.33	nu star (bias corrected)	93.02
Adjusted Level of Significance (β)	0.0437		
Approximate Chi Square Value (93.02, α)	71.78	Adjusted Chi Square Value (93.02, β)	71.05
95% Gamma Approximate UCL (use when n>=50)	1.035	95% Gamma Adjusted UCL (use when n<50)	1.046

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.306	SD (KM)	1.025
Variance (KM)	1.05	SE of Mean (KM)	0.382
k hat (KM)	1.623	k star (KM)	1.516
nu hat (KM)	126.6	nu star (KM)	118.2
theta hat (KM)	0.804	theta star (KM)	0.861
80% gamma percentile (KM)	2.018	90% gamma percentile (KM)	2.714
95% gamma percentile (KM)	3.389	99% gamma percentile (KM)	4.913

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (118.22, α)	94.11	Adjusted Chi Square Value (118.22, β)	93.26
95% Gamma Approximate KM-UCL (use when n>=50)	1.64	95% Gamma Adjusted KM-UCL (use when n<50)	1.655

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.221	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.883	Mean in Log Scale	-0.243
SD in Original Scale	0.564	SD in Log Scale	0.459
95% t UCL (assumes normality of ROS data)	1.035	95% Percentile Bootstrap UCL	1.051
95% BCA Bootstrap UCL	1.075	95% Bootstrap t UCL	1.248
95% H-UCL (Log ROS)	1.003		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.0146	KM Geo Mean	0.986
KM SD (logged)	0.728	95% Critical H Value (KM-Log)	2.114
KM Standard Error of Mean (logged)	0.272	95% H-UCL (KM -Log)	1.649
KM SD (logged)	0.728	95% Critical H Value (KM-Log)	2.114
KM Standard Error of Mean (logged)	0.272		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.45	Mean in Log Scale	1.025
SD in Original Scale	1.411	SD in Log Scale	0.86
95% t UCL (Assumes normality)	3.831	95% H-Stat UCL	5.521

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 1.95

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	39
		Number of Missing Observations	0
Minimum	1.49	Mean	9.145
Maximum	39.3	Median	7.13
SD	8.04	Std. Error of Mean	1.199
Coefficient of Variation	0.879	Skewness	2

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.235	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	11.16	95% Adjusted-CLT UCL (Chen-1995)	11.5
		95% Modified-t UCL (Johnson-1978)	11.22

Gamma GOF Test

A-D Test Statistic	0.674	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.764	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.133	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.134	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.78	k star (bias corrected MLE)	1.676
Theta hat (MLE)	5.138	Theta star (bias corrected MLE)	5.456
nu hat (MLE)	160.2	nu star (bias corrected)	150.8
MLE Mean (bias corrected)	9.145	MLE Sd (bias corrected)	7.064
		Approximate Chi Square Value (0.05)	123.5
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	122.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	11.17	95% Adjusted Gamma UCL (use when n<50)	11.25

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0849	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.131	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.399	Mean of logged Data	1.907
Maximum of Logged Data	3.671	SD of logged Data	0.785

Assuming Lognormal Distribution

95% H-UCL	11.81	90% Chebyshev (MVUE) UCL	12.63
95% Chebyshev (MVUE) UCL	14.24	97.5% Chebyshev (MVUE) UCL	16.47
99% Chebyshev (MVUE) UCL	20.86		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	11.12	95% Jackknife UCL	11.16
95% Standard Bootstrap UCL	11.04	95% Bootstrap-t UCL	11.58
95% Hall's Bootstrap UCL	11.54	95% Percentile Bootstrap UCL	11.17
95% BCA Bootstrap UCL	11.69		
90% Chebyshev(Mean, Sd) UCL	12.74	95% Chebyshev(Mean, Sd) UCL	14.37
97.5% Chebyshev(Mean, Sd) UCL	16.63	99% Chebyshev(Mean, Sd) UCL	21.07

Suggested UCL to Use

95% Adjusted Gamma UCL 11.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	39	Number of Distinct Observations	39
Number of Detects	35	Number of Non-Detects	4
Number of Distinct Detects	35	Number of Distinct Non-Detects	4
Minimum Detect	26.2	Minimum Non-Detect	24
Maximum Detect	252	Maximum Non-Detect	26.5
Variance Detects	2046	Percent Non-Detects	10.26%
Mean Detects	87.03	SD Detects	45.23
Median Detects	74.1	CV Detects	0.52
Skewness Detects	1.615	Kurtosis Detects	3.947
Mean of Logged Detects	4.349	SD of Logged Detects	0.492

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.877	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.148	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	80.59	KM Standard Error of Mean	7.528
KM SD	46.33	95% KM (BCA) UCL	92.99
95% KM (t) UCL	93.28	95% KM (Percentile Bootstrap) UCL	93.24
95% KM (z) UCL	92.97	95% KM Bootstrap t UCL	96.2
90% KM Chebyshev UCL	103.2	95% KM Chebyshev UCL	113.4
97.5% KM Chebyshev UCL	127.6	99% KM Chebyshev UCL	155.5

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.392	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0998	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.149	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	4.432	k star (bias corrected MLE)	4.071
Theta hat (MLE)	19.64	Theta star (bias corrected MLE)	21.38
nu hat (MLE)	310.2	nu star (bias corrected)	285
Mean (detects)	87.03		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	11.1	Mean	79.42
Maximum	252	Median	71.1
SD	48.49	CV	0.611
k hat (MLE)	2.508	k star (bias corrected MLE)	2.332
Theta hat (MLE)	31.66	Theta star (bias corrected MLE)	34.05
nu hat (MLE)	195.7	nu star (bias corrected)	181.9
Adjusted Level of Significance (β)	0.0437		
Approximate Chi Square Value (181.93, α)	151.7	Adjusted Chi Square Value (181.93, β)	150.6
95% Gamma Approximate UCL (use when n>=50)	95.23	95% Gamma Adjusted UCL (use when n<50)	95.91

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	80.59	SD (KM)	46.33
Variance (KM)	2147	SE of Mean (KM)	7.528
k hat (KM)	3.025	k star (KM)	2.81
nu hat (KM)	236	nu star (KM)	219.2
theta hat (KM)	26.64	theta star (KM)	28.68
80% gamma percentile (KM)	115.9	90% gamma percentile (KM)	145
95% gamma percentile (KM)	172.4	99% gamma percentile (KM)	231.8

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (219.16, α)	185.9	Adjusted Chi Square Value (219.16, β)	184.7
95% Gamma Approximate KM-UCL (use when n>=50)	95.01	95% Gamma Adjusted KM-UCL (use when n<50)	95.63

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.978	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0952	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.148	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	80.79	Mean in Log Scale	4.238
SD in Original Scale	46.7	SD in Log Scale	0.573
95% t UCL (assumes normality of ROS data)	93.4	95% Percentile Bootstrap UCL	93.27
95% BCA Bootstrap UCL	95.26	95% Bootstrap t UCL	96
95% H-UCL (Log ROS)	98.06		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.23	KM Geo Mean	68.72
KM SD (logged)	0.579	95% Critical H Value (KM-Log)	1.981
KM Standard Error of Mean (logged)	0.0941	95% H-UCL (KM -Log)	97.88
KM SD (logged)	0.579	95% Critical H Value (KM-Log)	1.981
KM Standard Error of Mean (logged)	0.0941		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	79.38	Mean in Log Scale	4.162
SD in Original Scale	48.54	SD in Log Scale	0.729
95% t UCL (Assumes normality)	92.49	95% H-Stat UCL	107.5

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	95.63	95% GROS Adjusted Gamma UCL	95.91

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	41	Number of Distinct Observations	37
Number of Detects	26	Number of Non-Detects	15
Number of Distinct Detects	23	Number of Distinct Non-Detects	15
Minimum Detect	0.624	Minimum Non-Detect	0.599
Maximum Detect	4.1	Maximum Non-Detect	0.876
Variance Detects	0.786	Percent Non-Detects	36.59%
Mean Detects	1.395	SD Detects	0.887
Median Detects	1	CV Detects	0.636
Skewness Detects	1.655	Kurtosis Detects	2.248
Mean of Logged Detects	0.184	SD of Logged Detects	0.523

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.768	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.279	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.17	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.114	KM Standard Error of Mean	0.125
KM SD	0.785	95% KM (BCA) UCL	1.352
95% KM (t) UCL	1.325	95% KM (Percentile Bootstrap) UCL	1.323
95% KM (z) UCL	1.32	95% KM Bootstrap t UCL	1.416
90% KM Chebyshev UCL	1.49	95% KM Chebyshev UCL	1.66
97.5% KM Chebyshev UCL	1.896	99% KM Chebyshev UCL	2.36

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.662	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.749	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.23	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.172	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.514	k star (bias corrected MLE)	3.134
Theta hat (MLE)	0.397	Theta star (bias corrected MLE)	0.445
nu hat (MLE)	182.7	nu star (bias corrected)	163
Mean (detects)	1.395		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.902
Maximum	4.1	Median	0.805
SD	0.961	CV	1.065
k hat (MLE)	0.549	k star (bias corrected MLE)	0.525
Theta hat (MLE)	1.645	Theta star (bias corrected MLE)	1.72
nu hat (MLE)	44.98	nu star (bias corrected)	43.03
Adjusted Level of Significance (β)	0.0441		
Approximate Chi Square Value (43.03, α)	28.99	Adjusted Chi Square Value (43.03, β)	28.56
95% Gamma Approximate UCL (use when n>=50)	1.339	95% Gamma Adjusted UCL (use when n<50)	1.359

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.114	SD (KM)	0.785
Variance (KM)	0.617	SE of Mean (KM)	0.125
k hat (KM)	2.013	k star (KM)	1.882
nu hat (KM)	165	nu star (KM)	154.3
theta hat (KM)	0.554	theta star (KM)	0.592
80% gamma percentile (KM)	1.68	90% gamma percentile (KM)	2.198
95% gamma percentile (KM)	2.694	99% gamma percentile (KM)	3.799

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (154.28, α)	126.6	Adjusted Chi Square Value (154.28, β)	125.7
95% Gamma Approximate KM-UCL (use when n>=50)	1.358	95% Gamma Adjusted KM-UCL (use when n<50)	1.368

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.882	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.2	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.035	Mean in Log Scale	-0.212
SD in Original Scale	0.85	SD in Log Scale	0.676
95% t UCL (assumes normality of ROS data)	1.259	95% Percentile Bootstrap UCL	1.265
95% BCA Bootstrap UCL	1.3	95% Bootstrap t UCL	1.317
95% H-UCL (Log ROS)	1.264		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.055	KM Geo Mean	0.947
KM SD (logged)	0.517	95% Critical H Value (KM-Log)	1.908
KM Standard Error of Mean (logged)	0.0828	95% H-UCL (KM -Log)	1.265
KM SD (logged)	0.517	95% Critical H Value (KM-Log)	1.908
KM Standard Error of Mean (logged)	0.0828		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.016	Mean in Log Scale	-0.26
SD in Original Scale	0.864	SD in Log Scale	0.725
95% t UCL (Assumes normality)	1.243	95% H-Stat UCL	1.273

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	1.66

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	48	Number of Distinct Observations	42
Number of Detects	39	Number of Non-Detects	9
Number of Distinct Detects	35	Number of Distinct Non-Detects	7
Minimum Detect	1.49	Minimum Non-Detect	0.07
Maximum Detect	52.6	Maximum Non-Detect	0.923
Variance Detects	97.46	Percent Non-Detects	18.75%
Mean Detects	8.703	SD Detects	9.872
Median Detects	5.49	CV Detects	1.134
Skewness Detects	2.977	Kurtosis Detects	10.4
Mean of Logged Detects	1.78	SD of Logged Detects	0.832

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.657	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.939	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.268	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.14	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.085	KM Standard Error of Mean	1.376
KM SD	9.408	95% KM (BCA) UCL	9.518
95% KM (t) UCL	9.393	95% KM (Percentile Bootstrap) UCL	9.464
95% KM (z) UCL	9.347	95% KM Bootstrap t UCL	10.89
90% KM Chebyshev UCL	11.21	95% KM Chebyshev UCL	13.08
97.5% KM Chebyshev UCL	15.68	99% KM Chebyshev UCL	20.77

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.205	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.767	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.148	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.144	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.447	k star (bias corrected MLE)	1.352
Theta hat (MLE)	6.016	Theta star (bias corrected MLE)	6.435
nu hat (MLE)	112.8	nu star (bias corrected)	105.5
Mean (detects)	8.703		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.073
Maximum	52.6	Median	4.195
SD	9.516	CV	1.345
k hat (MLE)	0.467	k star (bias corrected MLE)	0.452
Theta hat (MLE)	15.14	Theta star (bias corrected MLE)	15.65
nu hat (MLE)	44.86	nu star (bias corrected)	43.39
Adjusted Level of Significance (β)	0.045		
Approximate Chi Square Value (43.39, α)	29.29	Adjusted Chi Square Value (43.39, β)	28.93
95% Gamma Approximate UCL (use when n>=50)	10.48	95% Gamma Adjusted UCL (use when n<50)	10.61

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.085	SD (KM)	9.408
Variance (KM)	88.51	SE of Mean (KM)	1.376
k hat (KM)	0.567	k star (KM)	0.546
nu hat (KM)	54.44	nu star (KM)	52.37
theta hat (KM)	12.49	theta star (KM)	12.99
80% gamma percentile (KM)	11.67	90% gamma percentile (KM)	18.82
95% gamma percentile (KM)	26.38	99% gamma percentile (KM)	44.83

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (52.37, α)	36.75	Adjusted Chi Square Value (52.37, β)	36.34
95% Gamma Approximate KM-UCL (use when n>=50)	10.1	95% Gamma Adjusted KM-UCL (use when n<50)	10.21

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.939	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0855	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.14	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.246	Mean in Log Scale	1.43
SD in Original Scale	9.392	SD in Log Scale	1.052
95% t UCL (assumes normality of ROS data)	9.52	95% Percentile Bootstrap UCL	9.588
95% BCA Bootstrap UCL	10.17	95% Bootstrap t UCL	10.83
95% H-UCL (Log ROS)	10.49		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.948	KM Geo Mean	2.579
KM SD (logged)	1.884	95% Critical H Value (KM-Log)	3.44
KM Standard Error of Mean (logged)	0.276	95% H-UCL (KM -Log)	39.19
KM SD (logged)	1.884	95% Critical H Value (KM-Log)	3.44
KM Standard Error of Mean (logged)	0.276		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	7.116	Mean in Log Scale	1.078
SD in Original Scale	9.484	SD in Log Scale	1.731
95% t UCL (Assumes normality)	9.413	95% H-Stat UCL	29.74

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 39.19

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	43
		Number of Missing Observations	0
Minimum	6.36	Mean	29.49
Maximum	154	Median	19.6
SD	27.06	Std. Error of Mean	4.034
Coefficient of Variation	0.918	Skewness	2.719

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.705	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	36.26	95% Adjusted-CLT UCL (Chen-1995)	37.87
		95% Modified-t UCL (Johnson-1978)	36.54

Gamma GOF Test

A-D Test Statistic	1.789	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.76	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.133	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.014	k star (bias corrected MLE)	1.895
Theta hat (MLE)	14.64	Theta star (bias corrected MLE)	15.56
nu hat (MLE)	181.3	nu star (bias corrected)	170.5
MLE Mean (bias corrected)	29.49	MLE Sd (bias corrected)	21.42
		Approximate Chi Square Value (0.05)	141.3
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	140.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	35.58	95% Adjusted Gamma UCL (use when n<50)	35.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.85	Mean of logged Data	3.116
Maximum of Logged Data	5.037	SD of logged Data	0.69

Assuming Lognormal Distribution

95% H-UCL	35.47	90% Chebyshev (MVUE) UCL	38
95% Chebyshev (MVUE) UCL	42.33	97.5% Chebyshev (MVUE) UCL	48.35
99% Chebyshev (MVUE) UCL	60.17		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	36.12	95% Jackknife UCL	36.26
95% Standard Bootstrap UCL	35.98	95% Bootstrap-t UCL	39.28
95% Hall's Bootstrap UCL	41.42	95% Percentile Bootstrap UCL	36.28
95% BCA Bootstrap UCL	39.29		
90% Chebyshev(Mean, Sd) UCL	41.59	95% Chebyshev(Mean, Sd) UCL	47.07
97.5% Chebyshev(Mean, Sd) UCL	54.68	99% Chebyshev(Mean, Sd) UCL	69.63

Suggested UCL to Use

95% H-UCL 35.47

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	41	Number of Distinct Observations	37
Number of Detects	34	Number of Non-Detects	7
Number of Distinct Detects	30	Number of Distinct Non-Detects	7
Minimum Detect	7.45	Minimum Non-Detect	5.99
Maximum Detect	100	Maximum Non-Detect	8.76
Variance Detects	279.7	Percent Non-Detects	17.07%
Mean Detects	17.15	SD Detects	16.72
Median Detects	11.1	CV Detects	0.975
Skewness Detects	3.978	Kurtosis Detects	18.8
Mean of Logged Detects	2.624	SD of Logged Detects	0.58

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.547	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.933	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.15	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	15.3	KM Standard Error of Mean	2.465
KM SD	15.55	95% KM (BCA) UCL	19.89
95% KM (t) UCL	19.45	95% KM (Percentile Bootstrap) UCL	19.73
95% KM (z) UCL	19.35	95% KM Bootstrap t UCL	23.46
90% KM Chebyshev UCL	22.7	95% KM Chebyshev UCL	26.05
97.5% KM Chebyshev UCL	30.7	99% KM Chebyshev UCL	39.83

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.466	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.229	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.153	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.448	k star (bias corrected MLE)	2.251
Theta hat (MLE)	7.006	Theta star (bias corrected MLE)	7.618
nu hat (MLE)	166.4	nu star (bias corrected)	153.1
Mean (detects)	17.15		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	14.22
Maximum	100	Median	10
SD	16.53	CV	1.163
k hat (MLE)	0.502	k star (bias corrected MLE)	0.481
Theta hat (MLE)	28.34	Theta star (bias corrected MLE)	29.55
nu hat (MLE)	41.15	nu star (bias corrected)	39.47
Adjusted Level of Significance (β)	0.0441		
Approximate Chi Square Value (39.47, α)	26.08	Adjusted Chi Square Value (39.47, β)	25.68
95% Gamma Approximate UCL (use when n>=50)	21.53	95% Gamma Adjusted UCL (use when n<50)	21.86

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	15.3	SD (KM)	15.55
Variance (KM)	241.8	SE of Mean (KM)	2.465
k hat (KM)	0.968	k star (KM)	0.913
nu hat (KM)	79.37	nu star (KM)	74.89
theta hat (KM)	15.81	theta star (KM)	16.75
80% gamma percentile (KM)	24.79	90% gamma percentile (KM)	36.02
95% gamma percentile (KM)	47.33	99% gamma percentile (KM)	73.77

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (74.89, α)	55.96	Adjusted Chi Square Value (74.89, β)	55.37
95% Gamma Approximate KM-UCL (use when n>=50)	20.47	95% Gamma Adjusted KM-UCL (use when n<50)	20.7

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.201	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.15	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	14.96	Mean in Log Scale	2.424
SD in Original Scale	15.96	SD in Log Scale	0.693
95% t UCL (assumes normality of ROS data)	19.15	95% Percentile Bootstrap UCL	19.57
95% BCA Bootstrap UCL	21.41	95% Bootstrap t UCL	23.01
95% H-UCL (Log ROS)	17.96		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.49	KM Geo Mean	12.06
KM SD (logged)	0.6	95% Critical H Value (KM-Log)	1.971
KM Standard Error of Mean (logged)	0.0954	95% H-UCL (KM -Log)	17.41
KM SD (logged)	0.6	95% Critical H Value (KM-Log)	1.971
KM Standard Error of Mean (logged)	0.0954		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	14.83	Mean in Log Scale	2.392
SD in Original Scale	16.05	SD in Log Scale	0.741
95% t UCL (Assumes normality)	19.05	95% H-Stat UCL	18.38

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	26.05

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	40
		Number of Missing Observations	0
Minimum	3.84	Mean	13.43
Maximum	81.9	Median	10
SD	12.23	Std. Error of Mean	1.823
Coefficient of Variation	0.91	Skewness	4.243

Normal GOF Test

Shapiro Wilk Test Statistic	0.6	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.216	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	16.5	95% Adjusted-CLT UCL (Chen-1995)	17.66
		95% Modified-t UCL (Johnson-1978)	16.69

Gamma GOF Test

A-D Test Statistic	1.109	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.126	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.133	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.529	k star (bias corrected MLE)	2.375
Theta hat (MLE)	5.312	Theta star (bias corrected MLE)	5.656
nu hat (MLE)	227.6	nu star (bias corrected)	213.8
MLE Mean (bias corrected)	13.43	MLE Sd (bias corrected)	8.716
		Approximate Chi Square Value (0.05)	180.9
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	179.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	15.87	95% Adjusted Gamma UCL (use when n<50)	15.96

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0892	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.131	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.345	Mean of logged Data	2.387
Maximum of Logged Data	4.405	SD of logged Data	0.602

Assuming Lognormal Distribution

95% H-UCL	15.62	90% Chebyshev (MVUE) UCL	16.72
95% Chebyshev (MVUE) UCL	18.42	97.5% Chebyshev (MVUE) UCL	20.77
99% Chebyshev (MVUE) UCL	25.39		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	16.43	95% Jackknife UCL	16.5
95% Standard Bootstrap UCL	16.47	95% Bootstrap-t UCL	19.24
95% Hall's Bootstrap UCL	29.41	95% Percentile Bootstrap UCL	16.67
95% BCA Bootstrap UCL	17.93		
90% Chebyshev(Mean, Sd) UCL	18.9	95% Chebyshev(Mean, Sd) UCL	21.38
97.5% Chebyshev(Mean, Sd) UCL	24.82	99% Chebyshev(Mean, Sd) UCL	31.57

Suggested UCL to Use

95% Adjusted Gamma UCL 15.96

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	40
		Number of Missing Observations	0
Minimum	6860	Mean	28738
Maximum	147000	Median	14900
SD	31230	Std. Error of Mean	4655
Coefficient of Variation	1.087	Skewness	2.289

Normal GOF Test

Shapiro Wilk Test Statistic	0.66	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.272	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	36560	95% Adjusted-CLT UCL (Chen-1995)	38093
		95% Modified-t UCL (Johnson-1978)	36825

Gamma GOF Test

A-D Test Statistic	3.061	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.768	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.199	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.134	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.514	k star (bias corrected MLE)	1.428
Theta hat (MLE)	18985	Theta star (bias corrected MLE)	20130
nu hat (MLE)	136.2	nu star (bias corrected)	128.5
MLE Mean (bias corrected)	28738	MLE Sd (bias corrected)	24052
		Approximate Chi Square Value (0.05)	103.3
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	102.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	35743	95% Adjusted Gamma UCL (use when n<50)	36003

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.893	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.833	Mean of logged Data	9.901
Maximum of Logged Data	11.9	SD of logged Data	0.784

Assuming Lognormal Distribution

95% H-UCL	34933	90% Chebyshev (MVUE) UCL	37350
95% Chebyshev (MVUE) UCL	42096	97.5% Chebyshev (MVUE) UCL	48683
99% Chebyshev (MVUE) UCL	61623		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	36395	95% Jackknife UCL	36560
95% Standard Bootstrap UCL	36332	95% Bootstrap-t UCL	39463
95% Hall's Bootstrap UCL	37913	95% Percentile Bootstrap UCL	36784
95% BCA Bootstrap UCL	38038		
90% Chebyshev(Mean, Sd) UCL	42704	95% Chebyshev(Mean, Sd) UCL	49030
97.5% Chebyshev(Mean, Sd) UCL	57811	99% Chebyshev(Mean, Sd) UCL	75059

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 49030

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	48	Number of Distinct Observations	46
		Number of Missing Observations	0
Minimum	15.5	Mean	107.9
Maximum	1060	Median	65.6
SD	165.6	Std. Error of Mean	23.9
Coefficient of Variation	1.535	Skewness	4.534

Normal GOF Test

Shapiro Wilk Test Statistic	0.505	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.292	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	148	95% Adjusted-CLT UCL (Chen-1995)	163.9
		95% Modified-t UCL (Johnson-1978)	150.6

Gamma GOF Test

A-D Test Statistic	1.73	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.776	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.151	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.131	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.143	k star (bias corrected MLE)	1.085
Theta hat (MLE)	94.42	Theta star (bias corrected MLE)	99.43
nu hat (MLE)	109.7	nu star (bias corrected)	104.2
MLE Mean (bias corrected)	107.9	MLE Sd (bias corrected)	103.6
		Approximate Chi Square Value (0.05)	81.61
Adjusted Level of Significance	0.045	Adjusted Chi Square Value	80.99

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	137.7	95% Adjusted Gamma UCL (use when n<50)	138.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.947	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0732	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.127	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.741	Mean of logged Data	4.183
Maximum of Logged Data	6.966	SD of logged Data	0.912

Assuming Lognormal Distribution

95% H-UCL	134.1	90% Chebyshev (MVUE) UCL	142.9
95% Chebyshev (MVUE) UCL	163.1	97.5% Chebyshev (MVUE) UCL	191.2
99% Chebyshev (MVUE) UCL	246.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	147.2	95% Jackknife UCL	148
95% Standard Bootstrap UCL	146.5	95% Bootstrap-t UCL	196.8
95% Hall's Bootstrap UCL	301.2	95% Percentile Bootstrap UCL	151.3
95% BCA Bootstrap UCL	168.2		
90% Chebyshev(Mean, Sd) UCL	179.6	95% Chebyshev(Mean, Sd) UCL	212.1
97.5% Chebyshev(Mean, Sd) UCL	257.1	99% Chebyshev(Mean, Sd) UCL	345.7

Suggested UCL to Use

95% H-UCL 134.1

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Manganese (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	44
		Number of Missing Observations	0
Minimum	43.5	Mean	535.5
Maximum	1920	Median	450
SD	389.8	Std. Error of Mean	58.11
Coefficient of Variation	0.728	Skewness	1.943

Normal GOF Test

Shapiro Wilk Test Statistic	0.825	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.182	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	633.1	95% Adjusted-CLT UCL (Chen-1995)	649.1
		95% Modified-t UCL (Johnson-1978)	635.9

Gamma GOF Test

A-D Test Statistic	0.466	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.76	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0921	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.133	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.151	k star (bias corrected MLE)	2.022
Theta hat (MLE)	248.9	Theta star (bias corrected MLE)	264.8
nu hat (MLE)	193.6	nu star (bias corrected)	182
MLE Mean (bias corrected)	535.5	MLE Sd (bias corrected)	376.5
		Approximate Chi Square Value (0.05)	151.8
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	150.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	642	95% Adjusted Gamma UCL (use when n<50)	645.9

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.121	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.131	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.773	Mean of logged Data	6.033
Maximum of Logged Data	7.56	SD of logged Data	0.771

Assuming Lognormal Distribution

95% H-UCL	719.1	90% Chebyshev (MVUE) UCL	769.1
95% Chebyshev (MVUE) UCL	865.5	97.5% Chebyshev (MVUE) UCL	999.2
99% Chebyshev (MVUE) UCL	1262		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	631.1	95% Jackknife UCL	633.1
95% Standard Bootstrap UCL	628.8	95% Bootstrap-t UCL	659
95% Hall's Bootstrap UCL	684.3	95% Percentile Bootstrap UCL	633.1
95% BCA Bootstrap UCL	652		
90% Chebyshev(Mean, Sd) UCL	709.8	95% Chebyshev(Mean, Sd) UCL	788.8
97.5% Chebyshev(Mean, Sd) UCL	898.4	99% Chebyshev(Mean, Sd) UCL	1114

Suggested UCL to Use

95% Adjusted Gamma UCL 645.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	39	Number of Distinct Observations	31
Number of Detects	12	Number of Non-Detects	27
Number of Distinct Detects	11	Number of Distinct Non-Detects	21
Minimum Detect	0.00589	Minimum Non-Detect	0.121
Maximum Detect	1.09	Maximum Non-Detect	0.195
Variance Detects	0.0969	Percent Non-Detects	69.23%
Mean Detects	0.184	SD Detects	0.311
Median Detects	0.0628	CV Detects	1.692
Skewness Detects	2.67	Kurtosis Detects	7.431
Mean of Logged Detects	-2.742	SD of Logged Detects	1.567

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.605	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.364	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0874	KM Standard Error of Mean	0.0318
KM SD	0.18	95% KM (BCA) UCL	0.145
95% KM (t) UCL	0.141	95% KM (Percentile Bootstrap) UCL	0.141
95% KM (z) UCL	0.14	95% KM Bootstrap t UCL	0.207
90% KM Chebyshev UCL	0.183	95% KM Chebyshev UCL	0.226
97.5% KM Chebyshev UCL	0.286	99% KM Chebyshev UCL	0.404

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.473	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.778	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.201	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.257	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.59	k star (bias corrected MLE)	0.498
Theta hat (MLE)	0.312	Theta star (bias corrected MLE)	0.369
nu hat (MLE)	14.17	nu star (bias corrected)	11.96
Mean (detects)	0.184		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00589	Mean	0.0695
Maximum	1.09	Median	0.01
SD	0.185	CV	2.664
k hat (MLE)	0.556	k star (bias corrected MLE)	0.531
Theta hat (MLE)	0.125	Theta star (bias corrected MLE)	0.131
nu hat (MLE)	43.39	nu star (bias corrected)	41.38
Adjusted Level of Significance (β)	0.0437		
Approximate Chi Square Value (41.38, α)	27.64	Adjusted Chi Square Value (41.38, β)	27.19
95% Gamma Approximate UCL (use when n>=50)	0.104	95% Gamma Adjusted UCL (use when n<50)	0.106

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0874	SD (KM)	0.18
Variance (KM)	0.0324	SE of Mean (KM)	0.0318
k hat (KM)	0.236	k star (KM)	0.235
nu hat (KM)	18.38	nu star (KM)	18.3
theta hat (KM)	0.371	theta star (KM)	0.372
80% gamma percentile (KM)	0.124	90% gamma percentile (KM)	0.263
95% gamma percentile (KM)	0.431	99% gamma percentile (KM)	0.881

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.30, α)	9.61	Adjusted Chi Square Value (18.30, β)	9.361
95% Gamma Approximate KM-UCL (use when n>=50)	0.166	95% Gamma Adjusted KM-UCL (use when n<50)	0.171

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.139	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0778	Mean in Log Scale	-3.305
SD in Original Scale	0.182	SD in Log Scale	0.975
95% t UCL (assumes normality of ROS data)	0.127	95% Percentile Bootstrap UCL	0.128
95% BCA Bootstrap UCL	0.166	95% Bootstrap t UCL	0.304
95% H-UCL (Log ROS)	0.0859		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.299	KM Geo Mean	0.0369
KM SD (logged)	1.247	95% Critical H Value (KM-Log)	2.703
KM Standard Error of Mean (logged)	0.361	95% H-UCL (KM -Log)	0.139
KM SD (logged)	1.247	95% Critical H Value (KM-Log)	2.703
KM Standard Error of Mean (logged)	0.361		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.105	Mean in Log Scale	-2.694
SD in Original Scale	0.176	SD in Log Scale	0.849
95% t UCL (Assumes normality)	0.152	95% H-Stat UCL	0.132

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.171

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/kg)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	10	Mean	55
Maximum	100	Median	55

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Molybdenum (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Nickel (mg/kg)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	38
Number of Detects	30	Number of Non-Detects	15
Number of Distinct Detects	25	Number of Distinct Non-Detects	15
Minimum Detect	8	Minimum Non-Detect	5.2
Maximum Detect	87.6	Maximum Non-Detect	15.2
Variance Detects	369.2	Percent Non-Detects	33.33%
Mean Detects	26.06	SD Detects	19.21
Median Detects	20	CV Detects	0.737
Skewness Detects	1.811	Kurtosis Detects	3.047
Mean of Logged Detects	3.057	SD of Logged Detects	0.621

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.21	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	19.53	KM Standard Error of Mean	2.742
KM SD	18.03	95% KM (BCA) UCL	24.34
95% KM (t) UCL	24.14	95% KM (Percentile Bootstrap) UCL	24.17
95% KM (z) UCL	24.04	95% KM Bootstrap t UCL	25.36
90% KM Chebyshev UCL	27.76	95% KM Chebyshev UCL	31.49
97.5% KM Chebyshev UCL	36.66	99% KM Chebyshev UCL	46.82

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.906	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.162	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.615	k star (bias corrected MLE)	2.376
Theta hat (MLE)	9.967	Theta star (bias corrected MLE)	10.97
nu hat (MLE)	156.9	nu star (bias corrected)	142.5
Mean (detects)	26.06		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	17.47
Maximum	87.6	Median	12.6
SD	19.86	CV	1.137
k hat (MLE)	0.331	k star (bias corrected MLE)	0.324
Theta hat (MLE)	52.74	Theta star (bias corrected MLE)	53.92
nu hat (MLE)	29.82	nu star (bias corrected)	29.16
Adjusted Level of Significance (β)	0.0447		
Approximate Chi Square Value (29.16, α)	17.84	Adjusted Chi Square Value (29.16, β)	17.54
95% Gamma Approximate UCL (use when n>=50)	28.57	95% Gamma Adjusted UCL (use when n<50)	29.05

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	19.53	SD (KM)	18.03
Variance (KM)	325.1	SE of Mean (KM)	2.742
k hat (KM)	1.173	k star (KM)	1.11
nu hat (KM)	105.6	nu star (KM)	99.9
theta hat (KM)	16.65	theta star (KM)	17.6
80% gamma percentile (KM)	31.16	90% gamma percentile (KM)	43.83
95% gamma percentile (KM)	56.41	99% gamma percentile (KM)	85.39

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (99.90, α)	77.85	Adjusted Chi Square Value (99.90, β)	77.2
95% Gamma Approximate KM-UCL (use when n>=50)	25.07	95% Gamma Adjusted KM-UCL (use when n<50)	25.28

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.102	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	19.36	Mean in Log Scale	2.626
SD in Original Scale	18.32	SD in Log Scale	0.805
95% t UCL (assumes normality of ROS data)	23.95	95% Percentile Bootstrap UCL	23.99
95% BCA Bootstrap UCL	25.09	95% Bootstrap t UCL	25.3
95% H-UCL (Log ROS)	24.86		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.643	KM Geo Mean	14.06
KM SD (logged)	0.788	95% Critical H Value (KM-Log)	2.151
KM Standard Error of Mean (logged)	0.123	95% H-UCL (KM -Log)	24.77
KM SD (logged)	0.788	95% Critical H Value (KM-Log)	2.151
KM Standard Error of Mean (logged)	0.123		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	19.06	Mean in Log Scale	2.559
SD in Original Scale	18.56	SD in Log Scale	0.897
95% t UCL (Assumes normality)	23.71	95% H-Stat UCL	26.23

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	25.28	95% GROS Adjusted Gamma UCL	29.05

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	41	Number of Distinct Observations	36
Number of Detects	7	Number of Non-Detects	34
Number of Distinct Detects	7	Number of Distinct Non-Detects	29
Minimum Detect	6.9	Minimum Non-Detect	1.5
Maximum Detect	29.9	Maximum Non-Detect	6.13
Variance Detects	76.02	Percent Non-Detects	82.93%
Mean Detects	17.79	SD Detects	8.719
Median Detects	14	CV Detects	0.49
Skewness Detects	0.543	Kurtosis Detects	-1.162
Mean of Logged Detects	2.769	SD of Logged Detects	0.518

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.898	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	4.28	KM Standard Error of Mean	1.177
KM SD	6.977	95% KM (BCA) UCL	6.702
95% KM (t) UCL	6.262	95% KM (Percentile Bootstrap) UCL	6.424
95% KM (z) UCL	6.216	95% KM Bootstrap t UCL	6.178
90% KM Chebyshev UCL	7.811	95% KM Chebyshev UCL	9.41
97.5% KM Chebyshev UCL	11.63	99% KM Chebyshev UCL	15.99

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.317	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.71	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.313	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.726	k star (bias corrected MLE)	2.796
Theta hat (MLE)	3.763	Theta star (bias corrected MLE)	6.362
nu hat (MLE)	66.16	nu star (bias corrected)	39.14
Mean (detects)	17.79		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	3.045
Maximum	29.9	Median	0.01
SD	7.567	CV	2.485
k hat (MLE)	0.169	k star (bias corrected MLE)	0.173
Theta hat (MLE)	17.99	Theta star (bias corrected MLE)	17.58
nu hat (MLE)	13.88	nu star (bias corrected)	14.2
Adjusted Level of Significance (β)	0.0441		
Approximate Chi Square Value (14.20, α)	6.708	Adjusted Chi Square Value (14.20, β)	6.52
95% Gamma Approximate UCL (use when n>=50)	6.445	95% Gamma Adjusted UCL (use when n<50)	6.632

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	4.28	SD (KM)	6.977
Variance (KM)	48.68	SE of Mean (KM)	1.177
k hat (KM)	0.376	k star (KM)	0.365
nu hat (KM)	30.87	nu star (KM)	29.94
theta hat (KM)	11.37	theta star (KM)	11.72
80% gamma percentile (KM)	6.824	90% gamma percentile (KM)	12.28
95% gamma percentile (KM)	18.35	99% gamma percentile (KM)	33.77

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (29.94, α)	18.45	Adjusted Chi Square Value (29.94, β)	18.12
95% Gamma Approximate KM-UCL (use when n>=50)	6.948	95% Gamma Adjusted KM-UCL (use when n<50)	7.074

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.17	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.399	Mean in Log Scale	0.851
SD in Original Scale	7.03	SD in Log Scale	0.941
95% t UCL (assumes normality of ROS data)	6.248	95% Percentile Bootstrap UCL	6.426
95% BCA Bootstrap UCL	6.89	95% Bootstrap t UCL	7.397
95% H-UCL (Log ROS)	5.128		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.809	KM Geo Mean	2.246
KM SD (logged)	0.911	95% Critical H Value (KM-Log)	2.257
KM Standard Error of Mean (logged)	0.154	95% H-UCL (KM -Log)	4.708
KM SD (logged)	0.911	95% Critical H Value (KM-Log)	2.257
KM Standard Error of Mean (logged)	0.154		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	4.902	Mean in Log Scale	1.108
SD in Original Scale	6.832	SD in Log Scale	0.85
95% t UCL (Assumes normality)	6.699	95% H-Stat UCL	5.836

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 6.262

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	41	Number of Distinct Observations	32
Number of Detects	2	Number of Non-Detects	39
Number of Distinct Detects	2	Number of Distinct Non-Detects	30
Minimum Detect	2	Minimum Non-Detect	0.3
Maximum Detect	8	Maximum Non-Detect	1.98
Variance Detects	18	Percent Non-Detects	95.12%
Mean Detects	5	SD Detects	4.243
Median Detects	5	CV Detects	0.849
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.386	SD of Logged Detects	0.98

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.529	KM Standard Error of Mean	0.267
KM SD	1.21	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.979	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.969	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.331	95% KM Chebyshev UCL	1.694
97.5% KM Chebyshev UCL	2.198	99% KM Chebyshev UCL	3.188

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.394	k star (bias corrected MLE)	N/A
Theta hat (MLE)	2.088	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	9.577	nu star (bias corrected)	N/A
Mean (detects)	5		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.529	SD (KM)	1.21
Variance (KM)	1.464	SE of Mean (KM)	0.267
k hat (KM)	0.191	k star (KM)	0.194
nu hat (KM)	15.69	nu star (KM)	15.88
theta hat (KM)	2.766	theta star (KM)	2.734
80% gamma percentile (KM)	0.685	90% gamma percentile (KM)	1.6
95% gamma percentile (KM)	2.75	99% gamma percentile (KM)	5.933

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0441
Approximate Chi Square Value (15.88, α)	7.874	Adjusted Chi Square Value (15.88, β)	7.668
95% Gamma Approximate KM-UCL (use when n>=50)	1.067	95% Gamma Adjusted KM-UCL (use when n<50)	1.096

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.245	Mean in Log Scale	-7.866
SD in Original Scale	1.28	SD in Log Scale	2.55
95% t UCL (assumes normality of ROS data)	0.581	95% Percentile Bootstrap UCL	0.634
95% BCA Bootstrap UCL	0.976	95% Bootstrap t UCL	216.3
95% H-UCL (Log ROS)	0.0593		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.078	KM Geo Mean	0.34
KM SD (logged)	0.579	95% Critical H Value (KM-Log)	1.954
KM Standard Error of Mean (logged)	0.128	95% H-UCL (KM -Log)	0.481
KM SD (logged)	0.579	95% Critical H Value (KM-Log)	1.954
KM Standard Error of Mean (logged)	0.128		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.803	Mean in Log Scale	-0.549
SD in Original Scale	1.193	SD in Log Scale	0.718
95% t UCL (Assumes normality)	1.117	95% H-Stat UCL	0.946

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 1.694

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	39	Number of Distinct Observations	37
		Number of Missing Observations	0
Minimum	11.9	Mean	31.18
Maximum	90.1	Median	25
SD	18.41	Std. Error of Mean	2.948
Coefficient of Variation	0.59	Skewness	1.743

Normal GOF Test

Shapiro Wilk Test Statistic	0.8	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.939	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.14	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	36.15	95% Adjusted-CLT UCL (Chen-1995)	36.91
		95% Modified-t UCL (Johnson-1978)	36.29

Gamma GOF Test

A-D Test Statistic	1.194	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.187	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.142	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.951	k star (bias corrected MLE)	3.664
Theta hat (MLE)	7.893	Theta star (bias corrected MLE)	8.511
nu hat (MLE)	308.2	nu star (bias corrected)	285.8
MLE Mean (bias corrected)	31.18	MLE Sd (bias corrected)	16.29
		Approximate Chi Square Value (0.05)	247.6
Adjusted Level of Significance	0.0437	Adjusted Chi Square Value	246.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	35.99	95% Adjusted Gamma UCL (use when n<50)	36.19

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.939	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.14	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal Statistics

Minimum of Logged Data	2.477	Mean of logged Data	3.308
Maximum of Logged Data	4.501	SD of logged Data	0.495

Assuming Lognormal Distribution

95% H-UCL	36.04	90% Chebyshev (MVUE) UCL	38.46
95% Chebyshev (MVUE) UCL	41.94	97.5% Chebyshev (MVUE) UCL	46.76
99% Chebyshev (MVUE) UCL	56.23		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	36.03	95% Jackknife UCL	36.15
95% Standard Bootstrap UCL	35.97	95% Bootstrap-t UCL	37.74
95% Hall's Bootstrap UCL	37.17	95% Percentile Bootstrap UCL	35.91
95% BCA Bootstrap UCL	37.07		
90% Chebyshev(Mean, Sd) UCL	40.03	95% Chebyshev(Mean, Sd) UCL	44.03
97.5% Chebyshev(Mean, Sd) UCL	49.59	99% Chebyshev(Mean, Sd) UCL	60.51

Suggested UCL to Use

95% Student's-t UCL	36.15	or 95% Modified-t UCL	36.29
or 95% H-UCL	36.04		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Zinc (mg/kg)

General Statistics

Total Number of Observations	48	Number of Distinct Observations	46
		Number of Missing Observations	0
Minimum	56.8	Mean	1184
Maximum	7040	Median	919.5
SD	1272	Std. Error of Mean	183.5
Coefficient of Variation	1.074	Skewness	2.993

Normal GOF Test

Shapiro Wilk Test Statistic	0.686	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.221	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.127	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1492	95% Adjusted-CLT UCL (Chen-1995)	1570
		95% Modified-t UCL (Johnson-1978)	1505

Gamma GOF Test

A-D Test Statistic	0.807	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.772	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.101	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.131	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.286	k star (bias corrected MLE)	1.219
Theta hat (MLE)	920.7	Theta star (bias corrected MLE)	970.9
nu hat (MLE)	123.4	nu star (bias corrected)	117
MLE Mean (bias corrected)	1184	MLE Sd (bias corrected)	1072
		Approximate Chi Square Value (0.05)	93.07
Adjusted Level of Significance	0.045	Adjusted Chi Square Value	92.41

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1489	95% Adjusted Gamma UCL (use when n<50)	1499

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.947	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.127	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.04	Mean of logged Data	6.64
Maximum of Logged Data	8.859	SD of logged Data	1.01

Assuming Lognormal Distribution

95% H-UCL	1800	90% Chebyshev (MVUE) UCL	1900
95% Chebyshev (MVUE) UCL	2193	97.5% Chebyshev (MVUE) UCL	2599
99% Chebyshev (MVUE) UCL	3396		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1486	95% Jackknife UCL	1492
95% Standard Bootstrap UCL	1486	95% Bootstrap-t UCL	1634
95% Hall's Bootstrap UCL	1895	95% Percentile Bootstrap UCL	1503
95% BCA Bootstrap UCL	1607		
90% Chebyshev(Mean, Sd) UCL	1734	95% Chebyshev(Mean, Sd) UCL	1984
97.5% Chebyshev(Mean, Sd) UCL	2330	99% Chebyshev(Mean, Sd) UCL	3010

Appendix D, Table 12. ProUCL Output - Lower Spring River Sediment (Unsieved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Adjusted Gamma UCL 1499

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:53:40 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/L)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	36
Number of Detects	35	Number of Non-Detects	11
Number of Distinct Detects	34	Number of Distinct Non-Detects	2
Minimum Detect	0.0301	Minimum Non-Detect	0.1
Maximum Detect	3.42	Maximum Non-Detect	0.2
Variance Detects	0.513	Percent Non-Detects	23.91%
Mean Detects	0.621	SD Detects	0.716
Median Detects	0.386	CV Detects	1.154
Skewness Detects	2.267	Kurtosis Detects	6.207
Mean of Logged Detects	-1.077	SD of Logged Detects	1.183

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.755	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.211	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.148	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.493	KM Standard Error of Mean	0.0983
KM SD	0.657	95% KM (BCA) UCL	0.662
95% KM (t) UCL	0.658	95% KM (Percentile Bootstrap) UCL	0.647
95% KM (z) UCL	0.655	95% KM Bootstrap t UCL	0.717
90% KM Chebyshev UCL	0.788	95% KM Chebyshev UCL	0.922
97.5% KM Chebyshev UCL	1.107	99% KM Chebyshev UCL	1.471

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.319	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.777	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0826	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.153	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.966	k star (bias corrected MLE)	0.902
Theta hat (MLE)	0.643	Theta star (bias corrected MLE)	0.688
nu hat (MLE)	67.6	nu star (bias corrected)	63.14
Mean (detects)	0.621		

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.481
Maximum	3.42	Median	0.217
SD	0.672	CV	1.399
k hat (MLE)	0.59	k star (bias corrected MLE)	0.566
Theta hat (MLE)	0.814	Theta star (bias corrected MLE)	0.849
nu hat (MLE)	54.32	nu star (bias corrected)	52.11
Adjusted Level of Significance (β)	0.0448		
Approximate Chi Square Value (52.11, α)	36.53	Adjusted Chi Square Value (52.11, β)	36.1
95% Gamma Approximate UCL (use when n>=50)	0.686	95% Gamma Adjusted UCL (use when n<50)	0.694

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.493	SD (KM)	0.657
Variance (KM)	0.432	SE of Mean (KM)	0.0983
k hat (KM)	0.563	k star (KM)	0.541
nu hat (KM)	51.79	nu star (KM)	49.75
theta hat (KM)	0.876	theta star (KM)	0.911
80% gamma percentile (KM)	0.812	90% gamma percentile (KM)	1.312
95% gamma percentile (KM)	1.841	99% gamma percentile (KM)	3.134

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (49.75, α)	34.56	Adjusted Chi Square Value (49.75, β)	34.15
95% Gamma Approximate KM-UCL (use when n>=50)	0.71	95% Gamma Adjusted KM-UCL (use when n<50)	0.718

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.934	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0807	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.148	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.495	Mean in Log Scale	-1.423
SD in Original Scale	0.663	SD in Log Scale	1.237
95% t UCL (assumes normality of ROS data)	0.659	95% Percentile Bootstrap UCL	0.675
95% BCA Bootstrap UCL	0.7	95% Bootstrap t UCL	0.731
95% H-UCL (Log ROS)	0.835		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.434	KM Geo Mean	0.238
KM SD (logged)	1.226	95% Critical H Value (KM-Log)	2.579
KM Standard Error of Mean (logged)	0.19	95% H-UCL (KM -Log)	0.809
KM SD (logged)	1.226	95% Critical H Value (KM-Log)	2.579
KM Standard Error of Mean (logged)	0.19		

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.493	Mean in Log Scale	-1.415
SD in Original Scale	0.664	SD in Log Scale	1.206
95% t UCL (Assumes normality)	0.657	95% H-Stat UCL	0.795

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.718

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/L)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	5
Number of Detects	2	Number of Non-Detects	20
Number of Distinct Detects	2	Number of Distinct Non-Detects	3
Minimum Detect	0.0021	Minimum Non-Detect	2.0000E-4
Maximum Detect	0.0022	Maximum Non-Detect	0.06
Variance Detects	5.0000E-9	Percent Non-Detects	90.91%
Mean Detects	0.00215	SD Detects	7.0711E-5
Median Detects	0.00215	CV Detects	0.0329
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-6.143	SD of Logged Detects	0.0329

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.8000E-4	KM Standard Error of Mean	6.0452E-4
KM SD	9.5582E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00202	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.00197	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00279	95% KM Chebyshev UCL	0.00362
97.5% KM Chebyshev UCL	0.00476	99% KM Chebyshev UCL	0.00699

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	1849	k star (bias corrected MLE)	N/A
Theta hat (MLE)	1.1630E-6	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	7395	nu star (bias corrected)	N/A
Mean (detects)	0.00215		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.8000E-4	SD (KM)	9.5582E-4
Variance (KM)	9.1360E-7	SE of Mean (KM)	6.0452E-4
k hat (KM)	1.051	k star (KM)	0.938
nu hat (KM)	46.25	nu star (KM)	41.28
theta hat (KM)	9.3224E-4	theta star (KM)	0.00104
80% gamma percentile (KM)	0.00159	90% gamma percentile (KM)	0.00229
95% gamma percentile (KM)	0.003	99% gamma percentile (KM)	0.00466

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0386
Approximate Chi Square Value (41.28, α)	27.55	Adjusted Chi Square Value (41.28, β)	26.72
95% Gamma Approximate KM-UCL (use when n>=50)	0.00147	95% Gamma Adjusted KM-UCL (use when n<50)	0.00151

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00198	Mean in Log Scale	-6.225
SD in Original Scale	1.5233E-4	SD in Log Scale	0.0767
95% t UCL (assumes normality of ROS data)	0.00204	95% Percentile Bootstrap UCL	0.00204
95% BCA Bootstrap UCL	0.00204	95% Bootstrap t UCL	0.00204
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.567	KM Geo Mean	5.1707E-4
KM SD (logged)	1.163	95% Critical H Value (KM-Log)	2.817
KM Standard Error of Mean (logged)	0.736	95% H-UCL (KM -Log)	0.00208
KM SD (logged)	1.163	95% Critical H Value (KM-Log)	2.817
KM Standard Error of Mean (logged)	0.736		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0196	Mean in Log Scale	-4.863
SD in Original Scale	0.014	SD in Log Scale	2.065
95% t UCL (Assumes normality)	0.0248	95% H-Stat UCL	0.452

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00202	KM H-UCL	0.00208
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/L)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	5
Number of Detects	2	Number of Non-Detects	20
Number of Distinct Detects	2	Number of Distinct Non-Detects	3
Minimum Detect	9.0000E-4	Minimum Non-Detect	4.0000E-4
Maximum Detect	0.0031	Maximum Non-Detect	0.01
Variance Detects	2.4200E-6	Percent Non-Detects	90.91%
Mean Detects	0.002	SD Detects	0.00156
Median Detects	0.002	CV Detects	0.778
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-6.395	SD of Logged Detects	0.875

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0012	KM Standard Error of Mean	7.8899E-4
KM SD	0.00112	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00256	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0025	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00357	95% KM Chebyshev UCL	0.00464
97.5% KM Chebyshev UCL	0.00613	99% KM Chebyshev UCL	0.00905

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.932	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6.8216E-4	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	11.73	nu star (bias corrected)	N/A
Mean (detects)	0.002		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0012	SD (KM)	0.00112
Variance (KM)	1.2450E-6	SE of Mean (KM)	7.8899E-4
k hat (KM)	1.157	k star (KM)	1.029
nu hat (KM)	50.89	nu star (KM)	45.29
theta hat (KM)	0.00104	theta star (KM)	0.00117
80% gamma percentile (KM)	0.00193	90% gamma percentile (KM)	0.00274
95% gamma percentile (KM)	0.00356	99% gamma percentile (KM)	0.00545

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0386
Approximate Chi Square Value (45.29, α)	30.85	Adjusted Chi Square Value (45.29, β)	29.96
95% Gamma Approximate KM-UCL (use when n>=50)	0.00176	95% Gamma Adjusted KM-UCL (use when n<50)	0.00181

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00135	Mean in Log Scale	-8.006
SD in Original Scale	0.00256	SD in Log Scale	1.863
95% t UCL (assumes normality of ROS data)	0.00229	95% Percentile Bootstrap UCL	0.00233
95% BCA Bootstrap UCL	0.00282	95% Bootstrap t UCL	0.00363
95% H-UCL (Log ROS)	0.00941		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.109	KM Geo Mean	8.1739E-4
KM SD (logged)	0.838	95% Critical H Value (KM-Log)	2.368
KM Standard Error of Mean (logged)	0.592	95% H-UCL (KM -Log)	0.00179
KM SD (logged)	0.838	95% Critical H Value (KM-Log)	2.368
KM Standard Error of Mean (logged)	0.592		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00395	Mean in Log Scale	-5.785
SD in Original Scale	0.0017	SD in Log Scale	0.979
95% t UCL (Assumes normality)	0.00458	95% H-Stat UCL	0.00856

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.00464

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/L)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	6
Number of Distinct Detects	16	Number of Distinct Non-Detects	1

Minimum Detect	0.0412	Minimum Non-Detect	0.2
Maximum Detect	0.118	Maximum Non-Detect	0.2
Variance Detects	3.1690E-4	Percent Non-Detects	27.27%
Mean Detects	0.0634	SD Detects	0.0178
Median Detects	0.0599	CV Detects	0.281
Skewness Detects	1.959	Kurtosis Detects	5.73
Mean of Logged Detects	-2.79	SD of Logged Detects	0.249

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.819	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0634	KM Standard Error of Mean	0.00445
KM SD	0.0172	95% KM (BCA) UCL	0.0714
95% KM (t) UCL	0.071	95% KM (Percentile Bootstrap) UCL	0.0706
95% KM (z) UCL	0.0707	95% KM Bootstrap t UCL	0.0751
90% KM Chebyshev UCL	0.0767	95% KM Chebyshev UCL	0.0828
97.5% KM Chebyshev UCL	0.0912	99% KM Chebyshev UCL	0.108

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.58	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.737	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.17	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	16.29	k star (bias corrected MLE)	13.27
Theta hat (MLE)	0.00389	Theta star (bias corrected MLE)	0.00477
nu hat (MLE)	521.2	nu star (bias corrected)	424.8
Mean (detects)	0.0634		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0412	Mean	0.0633
Maximum	0.118	Median	0.0599
SD	0.0166	CV	0.262
k hat (MLE)	17.75	k star (bias corrected MLE)	15.36
Theta hat (MLE)	0.00357	Theta star (bias corrected MLE)	0.00412
nu hat (MLE)	780.9	nu star (bias corrected)	675.7
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (675.72, α)	616.4	Adjusted Chi Square Value (675.72, β)	612.2
95% Gamma Approximate UCL (use when n>=50)	0.0694	95% Gamma Adjusted UCL (use when n<50)	0.0698

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0634	SD (KM)	0.0172
Variance (KM)	2.9709E-4	SE of Mean (KM)	0.00445
k hat (KM)	13.51	k star (KM)	11.7
nu hat (KM)	594.6	nu star (KM)	514.9
theta hat (KM)	0.00469	theta star (KM)	0.00542
80% gamma percentile (KM)	0.0782	90% gamma percentile (KM)	0.088
95% gamma percentile (KM)	0.0966	99% gamma percentile (KM)	0.114

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (514.85, α)	463.2	Adjusted Chi Square Value (514.85, β)	459.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.0704	95% Gamma Adjusted KM-UCL (use when n<50)	0.071

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0631	Mean in Log Scale	-2.79
SD in Original Scale	0.0163	SD in Log Scale	0.233
95% t UCL (assumes normality of ROS data)	0.0691	95% Percentile Bootstrap UCL	0.069
95% BCA Bootstrap UCL	0.0705	95% Bootstrap t UCL	0.0708
95% H-UCL (Log ROS)	0.0692		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.79	KM Geo Mean	0.0614
KM SD (logged)	0.241	95% Critical H Value (KM-Log)	1.799
KM Standard Error of Mean (logged)	0.0622	95% H-UCL (KM -Log)	0.0695
KM SD (logged)	0.241	95% Critical H Value (KM-Log)	1.799
KM Standard Error of Mean (logged)	0.0622		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0734	Mean in Log Scale	-2.657
SD in Original Scale	0.0225	SD in Log Scale	0.306
95% t UCL (Assumes normality)	0.0816	95% H-Stat UCL	0.0831

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.071	95% GROS Adjusted Gamma UCL	0.0698

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Cadmium (mg/L)

General Statistics

Total Number of Observations	47	Number of Distinct Observations	43
Number of Detects	42	Number of Non-Detects	5
Number of Distinct Detects	42	Number of Distinct Non-Detects	1
Minimum Detect	2.7000E-4	Minimum Non-Detect	0.005
Maximum Detect	0.158	Maximum Non-Detect	0.005
Variance Detects	9.8904E-4	Percent Non-Detects	10.64%
Mean Detects	0.0321	SD Detects	0.0314
Median Detects	0.025	CV Detects	0.978
Skewness Detects	1.915	Kurtosis Detects	5.092
Mean of Logged Detects	-4.067	SD of Logged Detects	1.463

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.797	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.942	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.176	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0288	KM Standard Error of Mean	0.00457
KM SD	0.031	95% KM (BCA) UCL	0.0374
95% KM (t) UCL	0.0364	95% KM (Percentile Bootstrap) UCL	0.0364
95% KM (z) UCL	0.0363	95% KM Bootstrap t UCL	0.0384
90% KM Chebyshev UCL	0.0425	95% KM Chebyshev UCL	0.0487
97.5% KM Chebyshev UCL	0.0573	99% KM Chebyshev UCL	0.0742

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.395	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.781	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0862	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.141	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.926	k star (bias corrected MLE)	0.875
Theta hat (MLE)	0.0347	Theta star (bias corrected MLE)	0.0367
nu hat (MLE)	77.76	nu star (bias corrected)	73.54
Mean (detects)	0.0321		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum	2.7000E-4	Mean	0.0298
Maximum	0.158	Median	0.0188
SD	0.0305	CV	1.023
k hat (MLE)	0.951	k star (bias corrected MLE)	0.905
Theta hat (MLE)	0.0313	Theta star (bias corrected MLE)	0.0329
nu hat (MLE)	89.41	nu star (bias corrected)	85.03
Adjusted Level of Significance (β)	0.0449		
Approximate Chi Square Value (85.03, α)	64.78	Adjusted Chi Square Value (85.03, β)	64.22
95% Gamma Approximate UCL (use when n>=50)	0.0391	95% Gamma Adjusted UCL (use when n<50)	0.0394

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0288	SD (KM)	0.031
Variance (KM)	9.5805E-4	SE of Mean (KM)	0.00457
k hat (KM)	0.864	k star (KM)	0.823
nu hat (KM)	81.26	nu star (KM)	77.41
theta hat (KM)	0.0333	theta star (KM)	0.0349
80% gamma percentile (KM)	0.047	90% gamma percentile (KM)	0.0695
95% gamma percentile (KM)	0.0924	99% gamma percentile (KM)	0.146

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (77.41, α)	58.14	Adjusted Chi Square Value (77.41, β)	57.61
95% Gamma Approximate KM-UCL (use when n>=50)	0.0383	95% Gamma Adjusted KM-UCL (use when n<50)	0.0387

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.832	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.942	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.142	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0289	Mean in Log Scale	-4.325
SD in Original Scale	0.0312	SD in Log Scale	1.583
95% t UCL (assumes normality of ROS data)	0.0365	95% Percentile Bootstrap UCL	0.037
95% BCA Bootstrap UCL	0.0381	95% Bootstrap t UCL	0.0382
95% H-UCL (Log ROS)	0.0939		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.458	KM Geo Mean	0.0116
KM SD (logged)	1.783	95% Critical H Value (KM-Log)	3.293
KM Standard Error of Mean (logged)	0.266	95% H-UCL (KM -Log)	0.135
KM SD (logged)	1.783	95% Critical H Value (KM-Log)	3.293
KM Standard Error of Mean (logged)	0.266		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.029	Mean in Log Scale	-4.272
SD in Original Scale	0.0311	SD in Log Scale	1.506
95% t UCL (Assumes normality)	0.0366	95% H-Stat UCL	0.0831

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.0387

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/L)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	12
Number of Detects	10	Number of Non-Detects	22
Number of Distinct Detects	10	Number of Distinct Non-Detects	2
Minimum Detect	0.0013	Minimum Non-Detect	0.0011
Maximum Detect	0.0122	Maximum Non-Detect	0.01
Variance Detects	1.1060E-5	Percent Non-Detects	68.75%
Mean Detects	0.0032	SD Detects	0.00333
Median Detects	0.00195	CV Detects	1.04
Skewness Detects	2.676	Kurtosis Detects	7.459
Mean of Logged Detects	-6.023	SD of Logged Detects	0.685

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.599	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.356	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0024	KM Standard Error of Mean	4.6697E-4
KM SD	0.00203	95% KM (BCA) UCL	0.00326
95% KM (t) UCL	0.0032	95% KM (Percentile Bootstrap) UCL	0.0032
95% KM (z) UCL	0.00317	95% KM Bootstrap t UCL	0.00426
90% KM Chebyshev UCL	0.00381	95% KM Chebyshev UCL	0.00444
97.5% KM Chebyshev UCL	0.00532	99% KM Chebyshev UCL	0.00705

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.117	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.736	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.289	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.27	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.949	k star (bias corrected MLE)	1.431
Theta hat (MLE)	0.00164	Theta star (bias corrected MLE)	0.00224
nu hat (MLE)	38.98	nu star (bias corrected)	28.62
Mean (detects)	0.0032		

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0013	Mean	0.00787
Maximum	0.0122	Median	0.01
SD	0.00367	CV	0.466
k hat (MLE)	2.604	k star (bias corrected MLE)	2.381
Theta hat (MLE)	0.00302	Theta star (bias corrected MLE)	0.00331
nu hat (MLE)	166.7	nu star (bias corrected)	152.4
Adjusted Level of Significance (β)	0.0416		
Approximate Chi Square Value (152.38, α)	124.8	Adjusted Chi Square Value (152.38, β)	123.5
95% Gamma Approximate UCL (use when n>=50)	0.00961	95% Gamma Adjusted UCL (use when n<50)	0.00972

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0024	SD (KM)	0.00203
Variance (KM)	4.1224E-6	SE of Mean (KM)	4.6697E-4
k hat (KM)	1.403	k star (KM)	1.292
nu hat (KM)	89.79	nu star (KM)	82.71
theta hat (KM)	0.00171	theta star (KM)	0.00186
80% gamma percentile (KM)	0.00378	90% gamma percentile (KM)	0.0052
95% gamma percentile (KM)	0.00659	99% gamma percentile (KM)	0.00976

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (82.71, α)	62.75	Adjusted Chi Square Value (82.71, β)	61.82
95% Gamma Approximate KM-UCL (use when n>=50)	0.00317	95% Gamma Adjusted KM-UCL (use when n<50)	0.00322

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.816	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.231	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00246	Mean in Log Scale	-6.242
SD in Original Scale	0.00216	SD in Log Scale	0.664
95% t UCL (assumes normality of ROS data)	0.00311	95% Percentile Bootstrap UCL	0.00311
95% BCA Bootstrap UCL	0.0034	95% Bootstrap t UCL	0.00362
95% H-UCL (Log ROS)	0.00311		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.205	KM Geo Mean	0.00202
KM SD (logged)	0.514	95% Critical H Value (KM-Log)	1.943
KM Standard Error of Mean (logged)	0.144	95% H-UCL (KM -Log)	0.00276
KM SD (logged)	0.514	95% Critical H Value (KM-Log)	1.943
KM Standard Error of Mean (logged)	0.144		

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0043	Mean in Log Scale	-5.594
SD in Original Scale	0.00209	SD in Log Scale	0.61
95% t UCL (Assumes normality)	0.00493	95% H-Stat UCL	0.0056

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.00276

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/L)

General Statistics

Total Number of Observations	23	Number of Distinct Observations	12
Number of Detects	10	Number of Non-Detects	13
Number of Distinct Detects	10	Number of Distinct Non-Detects	2
Minimum Detect	4.5000E-4	Minimum Non-Detect	0.02
Maximum Detect	0.0078	Maximum Non-Detect	0.05
Variance Detects	4.6239E-6	Percent Non-Detects	56.52%
Mean Detects	0.00212	SD Detects	0.00215
Median Detects	0.00155	CV Detects	1.016
Skewness Detects	2.415	Kurtosis Detects	6.484
Mean of Logged Detects	-6.491	SD of Logged Detects	0.824

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.707	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.279	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00212	KM Standard Error of Mean	6.8000E-4
KM SD	0.00204	95% KM (BCA) UCL	0.00331
95% KM (t) UCL	0.00328	95% KM (Percentile Bootstrap) UCL	0.00337
95% KM (z) UCL	0.00324	95% KM Bootstrap t UCL	0.00523
90% KM Chebyshev UCL	0.00416	95% KM Chebyshev UCL	0.00508
97.5% KM Chebyshev UCL	0.00636	99% KM Chebyshev UCL	0.00888

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.394	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.205	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.271	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	1.649	k star (bias corrected MLE)	1.221
Theta hat (MLE)	0.00128	Theta star (bias corrected MLE)	0.00173
nu hat (MLE)	32.98	nu star (bias corrected)	24.42
Mean (detects)	0.00212		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.5000E-4	Mean	0.00657
Maximum	0.01	Median	0.01
SD	0.00423	CV	0.643
k hat (MLE)	1.393	k star (bias corrected MLE)	1.24
Theta hat (MLE)	0.00472	Theta star (bias corrected MLE)	0.0053
nu hat (MLE)	64.07	nu star (bias corrected)	57.05
Adjusted Level of Significance (β)	0.0389		
Approximate Chi Square Value (57.05, α)	40.69	Adjusted Chi Square Value (57.05, β)	39.68
95% Gamma Approximate UCL (use when n>=50)	0.00922	95% Gamma Adjusted UCL (use when n<50)	0.00945

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00212	SD (KM)	0.00204
Variance (KM)	4.1615E-6	SE of Mean (KM)	6.8000E-4
k hat (KM)	1.077	k star (KM)	0.965
nu hat (KM)	49.54	nu star (KM)	44.41
theta hat (KM)	0.00197	theta star (KM)	0.00219
80% gamma percentile (KM)	0.00342	90% gamma percentile (KM)	0.00492
95% gamma percentile (KM)	0.00642	99% gamma percentile (KM)	0.00992

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (44.41, α)	30.13	Adjusted Chi Square Value (44.41, β)	29.27
95% Gamma Approximate KM-UCL (use when n>=50)	0.00312	95% Gamma Adjusted KM-UCL (use when n<50)	0.00321

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.148	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00201	Mean in Log Scale	-6.491
SD in Original Scale	0.00171	SD in Log Scale	0.755
95% t UCL (assumes normality of ROS data)	0.00262	95% Percentile Bootstrap UCL	0.00261
95% BCA Bootstrap UCL	0.00277	95% Bootstrap t UCL	0.00298
95% H-UCL (Log ROS)	0.00289		

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.491	KM Geo Mean	0.00152
KM SD (logged)	0.782	95% Critical H Value (KM-Log)	2.258
KM Standard Error of Mean (logged)	0.261	95% H-UCL (KM -Log)	0.003
KM SD (logged)	0.782	95% Critical H Value (KM-Log)	2.258
KM Standard Error of Mean (logged)	0.261		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0118	Mean in Log Scale	-5.106
SD in Original Scale	0.0104	SD in Log Scale	1.392
95% t UCL (Assumes normality)	0.0155	95% H-Stat UCL	0.0398

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.00321	95% GROS Adjusted Gamma UCL	0.00945

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/L)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	37
Number of Detects	38	Number of Non-Detects	8
Number of Distinct Detects	35	Number of Distinct Non-Detects	2
Minimum Detect	0.0011	Minimum Non-Detect	0.02
Maximum Detect	0.0365	Maximum Non-Detect	0.025
Variance Detects	4.0118E-5	Percent Non-Detects	17.39%
Mean Detects	0.0104	SD Detects	0.00633
Median Detects	0.0094	CV Detects	0.609
Skewness Detects	1.96	Kurtosis Detects	6.998
Mean of Logged Detects	-4.757	SD of Logged Detects	0.69

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.854	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.938	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.169	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.142	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0102	KM Standard Error of Mean	9.3856E-4
KM SD	0.00597	95% KM (BCA) UCL	0.0119
95% KM (t) UCL	0.0118	95% KM (Percentile Bootstrap) UCL	0.0118
95% KM (z) UCL	0.0118	95% KM Bootstrap t UCL	0.0121
90% KM Chebyshev UCL	0.013	95% KM Chebyshev UCL	0.0143
97.5% KM Chebyshev UCL	0.0161	99% KM Chebyshev UCL	0.0196

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.861	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.166	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.144	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.782	k star (bias corrected MLE)	2.58
Theta hat (MLE)	0.00374	Theta star (bias corrected MLE)	0.00403
nu hat (MLE)	211.5	nu star (bias corrected)	196.1
Mean (detects)	0.0104		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.0105
Maximum	0.0365	Median	0.00999
SD	0.0058	CV	0.551
k hat (MLE)	3.292	k star (bias corrected MLE)	3.092
Theta hat (MLE)	0.0032	Theta star (bias corrected MLE)	0.00341
nu hat (MLE)	302.9	nu star (bias corrected)	284.4
Adjusted Level of Significance (β)	0.0448		
Approximate Chi Square Value (284.44, α)	246.4	Adjusted Chi Square Value (284.44, β)	245.2
95% Gamma Approximate UCL (use when n>=50)	0.0122	95% Gamma Adjusted UCL (use when n<50)	0.0122

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0102	SD (KM)	0.00597
Variance (KM)	3.5597E-5	SE of Mean (KM)	9.3856E-4
k hat (KM)	2.941	k star (KM)	2.764
nu hat (KM)	270.6	nu star (KM)	254.3
theta hat (KM)	0.00348	theta star (KM)	0.0037
80% gamma percentile (KM)	0.0147	90% gamma percentile (KM)	0.0185
95% gamma percentile (KM)	0.022	99% gamma percentile (KM)	0.0296

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (254.28, α)	218.4	Adjusted Chi Square Value (254.28, β)	217.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.0119	95% Gamma Adjusted KM-UCL (use when n<50)	0.012

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.938	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.142	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0101	Mean in Log Scale	-4.766
SD in Original Scale	0.00595	SD in Log Scale	0.648
95% t UCL (assumes normality of ROS data)	0.0116	95% Percentile Bootstrap UCL	0.0115
95% BCA Bootstrap UCL	0.0119	95% Bootstrap t UCL	0.0119
95% H-UCL (Log ROS)	0.0127		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.767	KM Geo Mean	0.00851
KM SD (logged)	0.674	95% Critical H Value (KM-Log)	2.012
KM Standard Error of Mean (logged)	0.11	95% H-UCL (KM -Log)	0.0131
KM SD (logged)	0.674	95% Critical H Value (KM-Log)	2.012
KM Standard Error of Mean (logged)	0.11		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0105	Mean in Log Scale	-4.716
SD in Original Scale	0.00577	SD in Log Scale	0.634
95% t UCL (Assumes normality)	0.0119	95% H-Stat UCL	0.0132

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0143

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/L)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	44
Number of Detects	45	Number of Non-Detects	1
Number of Distinct Detects	43	Number of Distinct Non-Detects	1
Minimum Detect	0.0506	Minimum Non-Detect	0.1
Maximum Detect	3.82	Maximum Non-Detect	0.1
Variance Detects	0.483	Percent Non-Detects	2.174%
Mean Detects	0.739	SD Detects	0.695
Median Detects	0.527	CV Detects	0.941
Skewness Detects	2.412	Kurtosis Detects	8.026
Mean of Logged Detects	-0.666	SD of Logged Detects	0.887

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.778	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.182	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.131	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.724	KM Standard Error of Mean	0.102
KM SD	0.687	95% KM (BCA) UCL	0.899
95% KM (t) UCL	0.896	95% KM (Percentile Bootstrap) UCL	0.908
95% KM (z) UCL	0.892	95% KM Bootstrap t UCL	0.959
90% KM Chebyshev UCL	1.031	95% KM Chebyshev UCL	1.17
97.5% KM Chebyshev UCL	1.363	99% KM Chebyshev UCL	1.742

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.399	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.768	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0848	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.134	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.523	k star (bias corrected MLE)	1.436
Theta hat (MLE)	0.485	Theta star (bias corrected MLE)	0.514
nu hat (MLE)	137.1	nu star (bias corrected)	129.2
Mean (detects)	0.739		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.723
Maximum	3.82	Median	0.52
SD	0.695	CV	0.962
k hat (MLE)	1.313	k star (bias corrected MLE)	1.242
Theta hat (MLE)	0.551	Theta star (bias corrected MLE)	0.582
nu hat (MLE)	120.8	nu star (bias corrected)	114.2
Adjusted Level of Significance (β)	0.0448		
Approximate Chi Square Value (114.24, α)	90.56	Adjusted Chi Square Value (114.24, β)	89.88
95% Gamma Approximate UCL (use when n>=50)	0.912	95% Gamma Adjusted UCL (use when n<50)	0.919

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.724	SD (KM)	0.687
Variance (KM)	0.472	SE of Mean (KM)	0.102
k hat (KM)	1.11	k star (KM)	1.052
nu hat (KM)	102.1	nu star (KM)	96.81
theta hat (KM)	0.652	theta star (KM)	0.688
80% gamma percentile (KM)	1.16	90% gamma percentile (KM)	1.645
95% gamma percentile (KM)	2.129	99% gamma percentile (KM)	3.248

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (96.81, α)	75.12	Adjusted Chi Square Value (96.81, β)	74.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.933	95% Gamma Adjusted KM-UCL (use when n<50)	0.94

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0892	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.724	Mean in Log Scale	-0.709
SD in Original Scale	0.694	SD in Log Scale	0.925
95% t UCL (assumes normality of ROS data)	0.896	95% Percentile Bootstrap UCL	0.892
95% BCA Bootstrap UCL	0.946	95% Bootstrap t UCL	0.949
95% H-UCL (Log ROS)	1.03		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.716	KM Geo Mean	0.489
KM SD (logged)	0.931	95% Critical H Value (KM-Log)	2.256
KM Standard Error of Mean (logged)	0.139	95% H-UCL (KM -Log)	1.031
KM SD (logged)	0.931	95% Critical H Value (KM-Log)	2.256
KM Standard Error of Mean (logged)	0.139		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.724	Mean in Log Scale	-0.717
SD in Original Scale	0.694	SD in Log Scale	0.942
95% t UCL (Assumes normality)	0.896	95% H-Stat UCL	1.047

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.94	95% GROS Adjusted Gamma UCL	0.919

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/L)

General Statistics

Total Number of Observations	44	Number of Distinct Observations	40
Number of Detects	38	Number of Non-Detects	6
Number of Distinct Detects	37	Number of Distinct Non-Detects	3

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	0.0011	Minimum Non-Detect	4.0000E-4
Maximum Detect	0.446	Maximum Non-Detect	0.01
Variance Detects	0.0132	Percent Non-Detects	13.64%
Mean Detects	0.0733	SD Detects	0.115
Median Detects	0.0309	CV Detects	1.569
Skewness Detects	2.517	Kurtosis Detects	5.276
Mean of Logged Detects	-3.382	SD of Logged Detects	1.231

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.565	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.938	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.341	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.142	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0635	KM Standard Error of Mean	0.0165
KM SD	0.108	95% KM (BCA) UCL	0.0929
95% KM (t) UCL	0.0913	95% KM (Percentile Bootstrap) UCL	0.0916
95% KM (z) UCL	0.0907	95% KM Bootstrap t UCL	0.109
90% KM Chebyshev UCL	0.113	95% KM Chebyshev UCL	0.136
97.5% KM Chebyshev UCL	0.167	99% KM Chebyshev UCL	0.228

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.09	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.787	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.192	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.149	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.775	k star (bias corrected MLE)	0.732
Theta hat (MLE)	0.0945	Theta star (bias corrected MLE)	0.1
nu hat (MLE)	58.92	nu star (bias corrected)	55.61
Mean (detects)	0.0733		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.0646
Maximum	0.446	Median	0.0271
SD	0.109	CV	1.684
k hat (MLE)	0.74	k star (bias corrected MLE)	0.705
Theta hat (MLE)	0.0873	Theta star (bias corrected MLE)	0.0917
nu hat (MLE)	65.14	nu star (bias corrected)	62.03
Adjusted Level of Significance (β)	0.0445		
Approximate Chi Square Value (62.03, α)	44.92	Adjusted Chi Square Value (62.03, β)	44.42
95% Gamma Approximate UCL (use when n>=50)	0.0893	95% Gamma Adjusted UCL (use when n<50)	0.0903

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0635	SD (KM)	0.108
Variance (KM)	0.0117	SE of Mean (KM)	0.0165
k hat (KM)	0.344	k star (KM)	0.336
nu hat (KM)	30.27	nu star (KM)	29.53
theta hat (KM)	0.185	theta star (KM)	0.189
80% gamma percentile (KM)	0.0997	90% gamma percentile (KM)	0.184
95% gamma percentile (KM)	0.28	99% gamma percentile (KM)	0.525

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (29.53, α)	18.13	Adjusted Chi Square Value (29.53, β)	17.82
95% Gamma Approximate KM-UCL (use when n>=50)	0.103	95% Gamma Adjusted KM-UCL (use when n<50)	0.105

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.938	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.108	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.142	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0636	Mean in Log Scale	-3.735
SD in Original Scale	0.109	SD in Log Scale	1.46
95% t UCL (assumes normality of ROS data)	0.0914	95% Percentile Bootstrap UCL	0.0923
95% BCA Bootstrap UCL	0.0976	95% Bootstrap t UCL	0.109
95% H-UCL (Log ROS)	0.133		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.898	KM Geo Mean	0.0203
KM SD (logged)	1.759	95% Critical H Value (KM-Log)	3.334
KM Standard Error of Mean (logged)	0.277	95% H-UCL (KM -Log)	0.233
KM SD (logged)	1.759	95% Critical H Value (KM-Log)	3.334
KM Standard Error of Mean (logged)	0.277		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0636	Mean in Log Scale	-3.821
SD in Original Scale	0.109	SD in Log Scale	1.679
95% t UCL (Assumes normality)	0.0913	95% H-Stat UCL	0.205

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	0.233

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Manganese (mg/L)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	46
		Number of Missing Observations	0
Minimum	0.0194	Mean	0.485
Maximum	3.19	Median	0.243
SD	0.63	Std. Error of Mean	0.0929
Coefficient of Variation	1.299	Skewness	2.659

Normal GOF Test

Shapiro Wilk Test Statistic	0.696	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.23	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.641	95% Adjusted-CLT UCL (Chen-1995)	0.677
		95% Modified-t UCL (Johnson-1978)	0.647

Gamma GOF Test

A-D Test Statistic	0.618	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.785	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.115	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.135	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.856	k star (bias corrected MLE)	0.815
Theta hat (MLE)	0.567	Theta star (bias corrected MLE)	0.596
nu hat (MLE)	78.75	nu star (bias corrected)	74.95
MLE Mean (bias corrected)	0.485	MLE Sd (bias corrected)	0.538
		Approximate Chi Square Value (0.05)	56.01
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	55.48

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	0.649	95% Adjusted Gamma UCL (use when n<50)	0.655

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.106	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.129	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.942	Mean of logged Data	-1.411
Maximum of Logged Data	1.16	SD of logged Data	1.242

Assuming Lognormal Distribution

95% H-UCL	0.854	90% Chebyshev (MVUE) UCL	0.863
95% Chebyshev (MVUE) UCL	1.022	97.5% Chebyshev (MVUE) UCL	1.242
99% Chebyshev (MVUE) UCL	1.675		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.638	95% Jackknife UCL	0.641
95% Standard Bootstrap UCL	0.634	95% Bootstrap-t UCL	0.727
95% Hall's Bootstrap UCL	0.749	95% Percentile Bootstrap UCL	0.642
95% BCA Bootstrap UCL	0.685		
90% Chebyshev(Mean, Sd) UCL	0.764	95% Chebyshev(Mean, Sd) UCL	0.89
97.5% Chebyshev(Mean, Sd) UCL	1.066	99% Chebyshev(Mean, Sd) UCL	1.41

Suggested UCL to Use

95% Adjusted Gamma UCL 0.655

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/L)

General Statistics

Total Number of Observations	42	Number of Distinct Observations	28
Number of Detects	29	Number of Non-Detects	13
Number of Distinct Detects	26	Number of Distinct Non-Detects	2
Minimum Detect	0.0021	Minimum Non-Detect	0.02
Maximum Detect	0.0326	Maximum Non-Detect	0.04
Variance Detects	6.6778E-5	Percent Non-Detects	30.95%
Mean Detects	0.017	SD Detects	0.00817
Median Detects	0.0157	CV Detects	0.481
Skewness Detects	0.296	Kurtosis Detects	-0.225
Mean of Logged Detects	-4.235	SD of Logged Detects	0.66

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.926	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.161	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0164	KM Standard Error of Mean	0.0014
KM SD	0.00776	95% KM (BCA) UCL	0.0187
95% KM (t) UCL	0.0188	95% KM (Percentile Bootstrap) UCL	0.0186
95% KM (z) UCL	0.0187	95% KM Bootstrap t UCL	0.0188
90% KM Chebyshev UCL	0.0206	95% KM Chebyshev UCL	0.0225
97.5% KM Chebyshev UCL	0.0252	99% KM Chebyshev UCL	0.0303

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.022	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.164	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.303	k star (bias corrected MLE)	2.984
Theta hat (MLE)	0.00514	Theta star (bias corrected MLE)	0.00569
nu hat (MLE)	191.6	nu star (bias corrected)	173.1
Mean (detects)	0.017		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0021	Mean	0.0164
Maximum	0.0326	Median	0.0156
SD	0.00736	CV	0.447
k hat (MLE)	4.122	k star (bias corrected MLE)	3.844
Theta hat (MLE)	0.00399	Theta star (bias corrected MLE)	0.00428
nu hat (MLE)	346.3	nu star (bias corrected)	322.9
Adjusted Level of Significance (β)	0.0443		
Approximate Chi Square Value (322.87, α)	282.2	Adjusted Chi Square Value (322.87, β)	280.9
95% Gamma Approximate UCL (use when n>=50)	0.0188	95% Gamma Adjusted UCL (use when n<50)	0.0189

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0164	SD (KM)	0.00776
Variance (KM)	6.0146E-5	SE of Mean (KM)	0.0014
k hat (KM)	4.481	k star (KM)	4.177
nu hat (KM)	376.4	nu star (KM)	350.8
theta hat (KM)	0.00366	theta star (KM)	0.00393
80% gamma percentile (KM)	0.0225	90% gamma percentile (KM)	0.0272
95% gamma percentile (KM)	0.0315	99% gamma percentile (KM)	0.0406

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (350.84, α)	308.4	Adjusted Chi Square Value (350.84, β)	307
95% Gamma Approximate KM-UCL (use when n>=50)	0.0187	95% Gamma Adjusted KM-UCL (use when n<50)	0.0188

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.835	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.926	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.24	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.161	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0161	Mean in Log Scale	-4.27
SD in Original Scale	0.00775	SD in Log Scale	0.599
95% t UCL (assumes normality of ROS data)	0.0181	95% Percentile Bootstrap UCL	0.0181
95% BCA Bootstrap UCL	0.0182	95% Bootstrap t UCL	0.0183
95% H-UCL (Log ROS)	0.0201		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.267	KM Geo Mean	0.014
KM SD (logged)	0.645	95% Critical H Value (KM-Log)	2.011
KM Standard Error of Mean (logged)	0.121	95% H-UCL (KM -Log)	0.0211
KM SD (logged)	0.645	95% Critical H Value (KM-Log)	2.011
KM Standard Error of Mean (logged)	0.121		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0167	Mean in Log Scale	-4.217
SD in Original Scale	0.0073	SD in Log Scale	0.578
95% t UCL (Assumes normality)	0.0186	95% H-Stat UCL	0.0208

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0188

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/L)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	4
Number of Detects	1	Number of Non-Detects	21
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Selenium (mg/L) was not processed!

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Vanadium (mg/L)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	20
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	6.0000E-4	Minimum Non-Detect	0.02
Maximum Detect	0.0022	Maximum Non-Detect	0.05
Variance Detects	1.2800E-6	Percent Non-Detects	90.91%
Mean Detects	0.0014	SD Detects	0.00113
Median Detects	0.0014	CV Detects	0.808
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-6.769	SD of Logged Detects	0.919

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0014	KM Standard Error of Mean	8.0000E-4
KM SD	8.0000E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00278	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.00272	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0038	95% KM Chebyshev UCL	0.00489
97.5% KM Chebyshev UCL	0.0064	99% KM Chebyshev UCL	0.00936

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	2.685	k star (bias corrected MLE)	N/A
Theta hat (MLE)	5.2149E-4	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	10.74	nu star (bias corrected)	N/A
Mean (detects)	0.0014		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0014	SD (KM)	8.0000E-4
Variance (KM)	6.4000E-7	SE of Mean (KM)	8.0000E-4
k hat (KM)	3.063	k star (KM)	2.675
nu hat (KM)	134.8	nu star (KM)	117.7
theta hat (KM)	4.5714E-4	theta star (KM)	5.2333E-4
80% gamma percentile (KM)	0.00202	90% gamma percentile (KM)	0.00255
95% gamma percentile (KM)	0.00304	99% gamma percentile (KM)	0.00411

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0386
Approximate Chi Square Value (117.71, α)	93.66	Adjusted Chi Square Value (117.71, β)	92.06
95% Gamma Approximate KM-UCL (use when n>=50)	0.00176	95% Gamma Adjusted KM-UCL (use when n<50)	0.00179

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00217	Mean in Log Scale	-6.769
SD in Original Scale	0.00271	SD in Log Scale	1.195
95% t UCL (assumes normality of ROS data)	0.00316	95% Percentile Bootstrap UCL	0.00311
95% BCA Bootstrap UCL	0.00339	95% Bootstrap t UCL	0.00393
95% H-UCL (Log ROS)	0.00495		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.769	KM Geo Mean	0.00115
KM SD (logged)	0.65	95% Critical H Value (KM-Log)	2.147
KM Standard Error of Mean (logged)	0.65	95% H-UCL (KM -Log)	0.00192
KM SD (logged)	0.65	95% Critical H Value (KM-Log)	2.147
KM Standard Error of Mean (logged)	0.65		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0194	Mean in Log Scale	-4.177
SD in Original Scale	0.00862	SD in Log Scale	0.945
95% t UCL (Assumes normality)	0.0226	95% H-Stat UCL	0.0403

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.00489

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/L)

General Statistics

Total Number of Observations	47	Number of Distinct Observations	46
Number of Detects	46	Number of Non-Detects	1
Number of Distinct Detects	45	Number of Distinct Non-Detects	1
Minimum Detect	0.0485	Minimum Non-Detect	0.02
Maximum Detect	23.5	Maximum Non-Detect	0.02
Variance Detects	25.85	Percent Non-Detects	2.128%
Mean Detects	5.246	SD Detects	5.085
Median Detects	3.895	CV Detects	0.969
Skewness Detects	1.6	Kurtosis Detects	3.477
Mean of Logged Detects	0.953	SD of Logged Detects	1.513

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.846	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.153	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.129	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.135	KM Standard Error of Mean	0.742
KM SD	5.032	95% KM (BCA) UCL	6.443
95% KM (t) UCL	6.381	95% KM (Percentile Bootstrap) UCL	6.375
95% KM (z) UCL	6.356	95% KM Bootstrap t UCL	6.694
90% KM Chebyshev UCL	7.362	95% KM Chebyshev UCL	8.37
97.5% KM Chebyshev UCL	9.77	99% KM Chebyshev UCL	12.52

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.612	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.786	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.124	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.135	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.838	k star (bias corrected MLE)	0.798
Theta hat (MLE)	6.263	Theta star (bias corrected MLE)	6.578
nu hat (MLE)	77.07	nu star (bias corrected)	73.37
Mean (detects)	5.246		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0485	Mean	5.139
Maximum	23.5	Median	3.69
SD	5.083	CV	0.989
k hat (MLE)	0.803	k star (bias corrected MLE)	0.766
Theta hat (MLE)	6.399	Theta star (bias corrected MLE)	6.709
nu hat (MLE)	75.49	nu star (bias corrected)	72.01
Adjusted Level of Significance (β)	0.0449		
Approximate Chi Square Value (72.01, α)	53.47	Adjusted Chi Square Value (72.01, β)	52.96
95% Gamma Approximate UCL (use when n>=50)	6.921	95% Gamma Adjusted UCL (use when n<50)	6.987

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.135	SD (KM)	5.032
Variance (KM)	25.32	SE of Mean (KM)	0.742
k hat (KM)	1.041	k star (KM)	0.989
nu hat (KM)	97.89	nu star (KM)	92.98
theta hat (KM)	4.931	theta star (KM)	5.192
80% gamma percentile (KM)	8.272	90% gamma percentile (KM)	11.86
95% gamma percentile (KM)	15.44	99% gamma percentile (KM)	23.78

Appendix D, Table 13. ProUCL Output - Elm Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (92.98, α)	71.74	Adjusted Chi Square Value (92.98, β)	71.15
95% Gamma Approximate KM-UCL (use when n>=50)	6.655	95% Gamma Adjusted KM-UCL (use when n<50)	6.711

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.159	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.136	Mean in Log Scale	0.874
SD in Original Scale	5.086	SD in Log Scale	1.592
95% t UCL (assumes normality of ROS data)	6.381	95% Percentile Bootstrap UCL	6.445
95% BCA Bootstrap UCL	6.66	95% Bootstrap t UCL	6.636
95% H-UCL (Log ROS)	17.38		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.85	KM Geo Mean	2.339
KM SD (logged)	1.639	95% Critical H Value (KM-Log)	3.101
KM Standard Error of Mean (logged)	0.242	95% H-UCL (KM -Log)	18.95
KM SD (logged)	1.639	95% Critical H Value (KM-Log)	3.101
KM Standard Error of Mean (logged)	0.242		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	5.135	Mean in Log Scale	0.835
SD in Original Scale	5.087	SD in Log Scale	1.702
95% t UCL (Assumes normality)	6.381	95% H-Stat UCL	21.82

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	6.711

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 5:04:53 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/L)

General Statistics

Total Number of Observations	1145	Number of Distinct Observations	719
Number of Detects	992	Number of Non-Detects	153
Number of Distinct Detects	716	Number of Distinct Non-Detects	12
Minimum Detect	0.00753	Minimum Non-Detect	0.03
Maximum Detect	7.36	Maximum Non-Detect	0.3
Variance Detects	0.669	Percent Non-Detects	13.36%
Mean Detects	0.417	SD Detects	0.818
Median Detects	0.112	CV Detects	1.961
Skewness Detects	3.946	Kurtosis Detects	19.39
Mean of Logged Detects	-1.914	SD of Logged Detects	1.35

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.513	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.309	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0284	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.372	KM Standard Error of Mean	0.0228
KM SD	0.77	95% KM (BCA) UCL	0.41
95% KM (t) UCL	0.41	95% KM (Percentile Bootstrap) UCL	0.41
95% KM (z) UCL	0.41	95% KM Bootstrap t UCL	0.414
90% KM Chebyshev UCL	0.441	95% KM Chebyshev UCL	0.471
97.5% KM Chebyshev UCL	0.514	99% KM Chebyshev UCL	0.599

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	53.7	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.814	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.179	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0303	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.595	k star (bias corrected MLE)	0.594
Theta hat (MLE)	0.702	Theta star (bias corrected MLE)	0.703
nu hat (MLE)	1180	nu star (bias corrected)	1178
Mean (detects)	0.417		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00753	Mean	0.373
Maximum	7.36	Median	0.0996
SD	0.772	CV	2.071
k hat (MLE)	0.539	k star (bias corrected MLE)	0.539
Theta hat (MLE)	0.691	Theta star (bias corrected MLE)	0.692
nu hat (MLE)	1235	nu star (bias corrected)	1234
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	1153	Adjusted Chi Square Value (N/A, β)	1153
95% Gamma Approximate UCL (use when n>=50)	0.399	95% Gamma Adjusted UCL (use when n<50)	0.399

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.372	SD (KM)	0.77
Variance (KM)	0.593	SE of Mean (KM)	0.0228
k hat (KM)	0.234	k star (KM)	0.234
nu hat (KM)	534.8	nu star (KM)	534.8
theta hat (KM)	1.594	theta star (KM)	1.594
80% gamma percentile (KM)	0.527	90% gamma percentile (KM)	1.122
95% gamma percentile (KM)	1.838	99% gamma percentile (KM)	3.763

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (534.76, α)	482.1	Adjusted Chi Square Value (534.76, β)	482.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.413	95% Gamma Adjusted KM-UCL (use when n<50)	0.413

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.943	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0917	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0284	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.374	Mean in Log Scale	-2.021
SD in Original Scale	0.77	SD in Log Scale	1.327
95% t UCL (assumes normality of ROS data)	0.412	95% Percentile Bootstrap UCL	0.414
95% BCA Bootstrap UCL	0.414	95% Bootstrap t UCL	0.415
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.03	KM Geo Mean	0.131
KM SD (logged)	1.317	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0397	95% H-UCL (KM -Log)	N/A
KM SD (logged)	1.317	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0397		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.377	Mean in Log Scale	-1.961
SD in Original Scale	0.769	SD in Log Scale	1.279
95% t UCL (Assumes normality)	0.415	95% H-Stat UCL	N/A

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.471

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/L)

General Statistics

Total Number of Observations	198	Number of Distinct Observations	9
Number of Detects	4	Number of Non-Detects	194
Number of Distinct Detects	3	Number of Distinct Non-Detects	6
Minimum Detect	7.0000E-4	Minimum Non-Detect	2.0000E-4
Maximum Detect	0.0033	Maximum Non-Detect	0.06
Variance Detects	1.5825E-6	Percent Non-Detects	97.98%
Mean Detects	0.00258	SD Detects	0.00126
Median Detects	0.00315	CV Detects	0.489
Skewness Detects	-1.927	Kurtosis Detects	3.73
Mean of Logged Detects	-6.125	SD of Logged Detects	0.761

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.711	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.382	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	3.0614E-4	KM Standard Error of Mean	6.0014E-5
KM SD	4.9688E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	4.0532E-4	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	4.0485E-4	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.8618E-4	95% KM Chebyshev UCL	5.6773E-4
97.5% KM Chebyshev UCL	6.8093E-4	99% KM Chebyshev UCL	9.0327E-4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.827	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.659	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.429	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.396	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.217	k star (bias corrected MLE)	0.971
Theta hat (MLE)	8.0044E-4	Theta star (bias corrected MLE)	0.00265
nu hat (MLE)	25.74	nu star (bias corrected)	7.767
Mean (detects)	0.00258		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.0000E-4	Mean	0.00985
Maximum	0.01	Median	0.01
SD	0.00106	CV	0.107
k hat (MLE)	32.22	k star (bias corrected MLE)	31.74
Theta hat (MLE)	3.0567E-4	Theta star (bias corrected MLE)	3.1034E-4
nu hat (MLE)	12761	nu star (bias corrected)	12569
Adjusted Level of Significance (β)	0.0488		
Approximate Chi Square Value (N/A, α)	12309	Adjusted Chi Square Value (N/A, β)	12307
95% Gamma Approximate UCL (use when n>=50)	0.0101	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	3.0614E-4	SD (KM)	4.9688E-4
Variance (KM)	2.4689E-7	SE of Mean (KM)	6.0014E-5
k hat (KM)	0.38	k star (KM)	0.377
nu hat (KM)	150.3	nu star (KM)	149.4
theta hat (KM)	8.0648E-4	theta star (KM)	8.1158E-4
80% gamma percentile (KM)	4.9039E-4	90% gamma percentile (KM)	8.7349E-4
95% gamma percentile (KM)	0.0013	99% gamma percentile (KM)	0.00237

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (149.37, α)	122.1	Adjusted Chi Square Value (149.37, β)	121.9
95% Gamma Approximate KM-UCL (use when n>=50)	3.7444E-4	95% Gamma Adjusted KM-UCL (use when n<50)	3.7499E-4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.674	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.411	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.7884E-4	Mean in Log Scale	-10.15
SD in Original Scale	4.5428E-4	SD in Log Scale	1.8
95% t UCL (assumes normality of ROS data)	2.3219E-4	95% Percentile Bootstrap UCL	2.3398E-4
95% BCA Bootstrap UCL	2.4815E-4	95% Bootstrap t UCL	2.5496E-4
95% H-UCL (Log ROS)	2.9072E-4		

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-8.381	KM Geo Mean	2.2926E-4
KM SD (logged)	0.517	95% Critical H Value (KM-Log)	1.827
KM Standard Error of Mean (logged)	0.084	95% H-UCL (KM -Log)	2.8027E-4
KM SD (logged)	0.517	95% Critical H Value (KM-Log)	1.827
KM Standard Error of Mean (logged)	0.084		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00638	Mean in Log Scale	-6.164
SD in Original Scale	0.0102	SD in Log Scale	1.553
95% t UCL (Assumes normality)	0.00758	95% H-Stat UCL	0.00948

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 5.6773E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/L)

General Statistics

Total Number of Observations	528	Number of Distinct Observations	242
Number of Detects	349	Number of Non-Detects	179
Number of Distinct Detects	239	Number of Distinct Non-Detects	6
Minimum Detect	5.0000E-4	Minimum Non-Detect	4.0000E-4
Maximum Detect	0.233	Maximum Non-Detect	0.03
Variance Detects	7.5456E-4	Percent Non-Detects	33.9%
Mean Detects	0.042	SD Detects	0.0275
Median Detects	0.0499	CV Detects	0.654
Skewness Detects	0.534	Kurtosis Detects	5.204
Mean of Logged Detects	-3.783	SD of Logged Detects	1.547

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.865	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0478	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0283	KM Standard Error of Mean	0.00128
KM SD	0.0294	95% KM (BCA) UCL	0.0303
95% KM (t) UCL	0.0304	95% KM (Percentile Bootstrap) UCL	0.0305
95% KM (z) UCL	0.0304	95% KM Bootstrap t UCL	0.0305
90% KM Chebyshev UCL	0.0321	95% KM Chebyshev UCL	0.0339
97.5% KM Chebyshev UCL	0.0363	99% KM Chebyshev UCL	0.0411

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	34.4	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.787	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.232	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0503	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.947	k star (bias corrected MLE)	0.941
Theta hat (MLE)	0.0443	Theta star (bias corrected MLE)	0.0446
nu hat (MLE)	661.3	nu star (bias corrected)	657
Mean (detects)	0.042		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.0000E-4	Mean	0.0335
Maximum	0.233	Median	0.0248
SD	0.0254	CV	0.757
k hat (MLE)	1.146	k star (bias corrected MLE)	1.141
Theta hat (MLE)	0.0293	Theta star (bias corrected MLE)	0.0294
nu hat (MLE)	1210	nu star (bias corrected)	1204
Adjusted Level of Significance (β)	0.0495		
Approximate Chi Square Value (N/A, α)	1125	Adjusted Chi Square Value (N/A, β)	1125
95% Gamma Approximate UCL (use when n>=50)	0.0359	95% Gamma Adjusted UCL (use when n<50)	0.0359

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0283	SD (KM)	0.0294
Variance (KM)	8.6569E-4	SE of Mean (KM)	0.00128
k hat (KM)	0.924	k star (KM)	0.92
nu hat (KM)	975.8	nu star (KM)	971.5
theta hat (KM)	0.0306	theta star (KM)	0.0307
80% gamma percentile (KM)	0.0458	90% gamma percentile (KM)	0.0665
95% gamma percentile (KM)	0.0873	99% gamma percentile (KM)	0.136

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (971.54, α)	900.2	Adjusted Chi Square Value (971.54, β)	900
95% Gamma Approximate KM-UCL (use when n>=50)	0.0305	95% Gamma Adjusted KM-UCL (use when n<50)	0.0305

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.708	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.269	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0478	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0289	Mean in Log Scale	-4.557
SD in Original Scale	0.0289	SD in Log Scale	1.76
95% t UCL (assumes normality of ROS data)	0.031	95% Percentile Bootstrap UCL	0.031
95% BCA Bootstrap UCL	0.0311	95% Bootstrap t UCL	0.031
95% H-UCL (Log ROS)	0.0614		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.838	KM Geo Mean	0.00792
KM SD (logged)	1.997	95% Critical H Value (KM-Log)	3.075
KM Standard Error of Mean (logged)	0.0923	95% H-UCL (KM -Log)	0.076
KM SD (logged)	1.997	95% Critical H Value (KM-Log)	3.075
KM Standard Error of Mean (logged)	0.0923		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0292	Mean in Log Scale	-4.445
SD in Original Scale	0.0286	SD in Log Scale	1.668
95% t UCL (Assumes normality)	0.0313	95% H-Stat UCL	0.0575

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0339

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/L)

General Statistics

Total Number of Observations	233	Number of Distinct Observations	115
Number of Detects	214	Number of Non-Detects	19
Number of Distinct Detects	113	Number of Distinct Non-Detects	2
Minimum Detect	0.008	Minimum Non-Detect	0.01
Maximum Detect	0.165	Maximum Non-Detect	0.2
Variance Detects	7.1791E-4	Percent Non-Detects	8.155%
Mean Detects	0.0469	SD Detects	0.0268
Median Detects	0.0445	CV Detects	0.572
Skewness Detects	1.794	Kurtosis Detects	4.551
Mean of Logged Detects	-3.203	SD of Logged Detects	0.537

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.849	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.161	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.061	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0467	KM Standard Error of Mean	0.00183
KM SD	0.0268	95% KM (BCA) UCL	0.0498
95% KM (t) UCL	0.0497	95% KM (Percentile Bootstrap) UCL	0.0497
95% KM (z) UCL	0.0497	95% KM Bootstrap t UCL	0.0499
90% KM Chebyshev UCL	0.0522	95% KM Chebyshev UCL	0.0547
97.5% KM Chebyshev UCL	0.0581	99% KM Chebyshev UCL	0.0649

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.647	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.758	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0944	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0623	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.68	k star (bias corrected MLE)	3.632
Theta hat (MLE)	0.0127	Theta star (bias corrected MLE)	0.0129
nu hat (MLE)	1575	nu star (bias corrected)	1554
Mean (detects)	0.0469		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.008	Mean	0.0466
Maximum	0.165	Median	0.044
SD	0.0265	CV	0.569
k hat (MLE)	3.63	k star (bias corrected MLE)	3.586
Theta hat (MLE)	0.0128	Theta star (bias corrected MLE)	0.013
nu hat (MLE)	1691	nu star (bias corrected)	1671
Adjusted Level of Significance (β)	0.049		
Approximate Chi Square Value (N/A, α)	1577	Adjusted Chi Square Value (N/A, β)	1576
95% Gamma Approximate UCL (use when n>=50)	0.0494	95% Gamma Adjusted UCL (use when n<50)	0.0494

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0467	SD (KM)	0.0268
Variance (KM)	7.1805E-4	SE of Mean (KM)	0.00183
k hat (KM)	3.035	k star (KM)	2.999
nu hat (KM)	1414	nu star (KM)	1397
theta hat (KM)	0.0154	theta star (KM)	0.0156
80% gamma percentile (KM)	0.0666	90% gamma percentile (KM)	0.0828
95% gamma percentile (KM)	0.098	99% gamma percentile (KM)	0.131

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1312	Adjusted Chi Square Value (N/A, β)	1311
95% Gamma Approximate KM-UCL (use when n>=50)	0.0497	95% Gamma Adjusted KM-UCL (use when n<50)	0.0498

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.977	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.151	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0877	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.061	Detected Data Not Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0466	Mean in Log Scale	-3.209
SD in Original Scale	0.0265	SD in Log Scale	0.539
95% t UCL (assumes normality of ROS data)	0.0494	95% Percentile Bootstrap UCL	0.0496
95% BCA Bootstrap UCL	0.0495	95% Bootstrap t UCL	0.0496
95% H-UCL (Log ROS)	0.0498		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.21	KM Geo Mean	0.0404
KM SD (logged)	0.545	95% Critical H Value (KM-Log)	1.831
KM Standard Error of Mean (logged)	0.0373	95% H-UCL (KM -Log)	0.05
KM SD (logged)	0.545	95% Critical H Value (KM-Log)	1.831
KM Standard Error of Mean (logged)	0.0373		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0508	Mean in Log Scale	-3.142
SD in Original Scale	0.0295	SD in Log Scale	0.586
95% t UCL (Assumes normality)	0.054	95% H-Stat UCL	0.0551

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.05

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/L)

General Statistics

Total Number of Observations	198	Number of Distinct Observations	6
Number of Detects	2	Number of Non-Detects	196
Number of Distinct Detects	2	Number of Distinct Non-Detects	4
Minimum Detect	2.0000E-4	Minimum Non-Detect	0.002
Maximum Detect	2.8000E-4	Maximum Non-Detect	0.02
Variance Detects	3.2000E-9	Percent Non-Detects	98.99%
Mean Detects	2.4000E-4	SD Detects	5.6569E-5
Median Detects	2.4000E-4	CV Detects	0.236
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-8.349	SD of Logged Detects	0.238

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.4000E-4	KM Standard Error of Mean	4.0000E-5
KM SD	4.0000E-5	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.0611E-4	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.0579E-4	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	3.6000E-4	95% KM Chebyshev UCL	4.1436E-4
97.5% KM Chebyshev UCL	4.8980E-4	99% KM Chebyshev UCL	6.3799E-4

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	35.66	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6.7296E-6	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	142.7	nu star (bias corrected)	N/A
Mean (detects)	2.4000E-4		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.4000E-4	SD (KM)	4.0000E-5
Variance (KM)	1.6000E-9	SE of Mean (KM)	4.0000E-5
k hat (KM)	36	k star (KM)	35.46
nu hat (KM)	14256	nu star (KM)	14041
theta hat (KM)	6.6667E-6	theta star (KM)	6.7686E-6
80% gamma percentile (KM)	2.7310E-4	90% gamma percentile (KM)	2.9288E-4
95% gamma percentile (KM)	3.0991E-4	99% gamma percentile (KM)	3.4358E-4

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0488
Approximate Chi Square Value (N/A, α)	13767	Adjusted Chi Square Value (N/A, β)	13765
95% Gamma Approximate KM-UCL (use when n>=50)	2.4479E-4	95% Gamma Adjusted KM-UCL (use when n<50)	2.4482E-4

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.5313E-4	Mean in Log Scale	-8.349
SD in Original Scale	9.5185E-5	SD in Log Scale	0.369
95% t UCL (assumes normality of ROS data)	2.6430E-4	95% Percentile Bootstrap UCL	2.6460E-4
95% BCA Bootstrap UCL	2.6492E-4	95% Bootstrap t UCL	2.6480E-4
95% H-UCL (Log ROS)	2.6520E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-8.349	KM Geo Mean	2.3664E-4
KM SD (logged)	0.168	95% Critical H Value (KM-Log)	1.682
KM Standard Error of Mean (logged)	0.168	95% H-UCL (KM -Log)	2.4490E-4
KM SD (logged)	0.168	95% Critical H Value (KM-Log)	1.682
KM Standard Error of Mean (logged)	0.168		

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00378	Mean in Log Scale	-5.688
SD in Original Scale	0.00172	SD in Log Scale	0.509
95% t UCL (Assumes normality)	0.00398	95% H-Stat UCL	0.00412

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.0611E-4	KM H-UCL	2.4490E-4
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/L)

General Statistics

Total Number of Observations	1177	Number of Distinct Observations	658
Number of Detects	1091	Number of Non-Detects	86
Number of Distinct Detects	658	Number of Distinct Non-Detects	6
Minimum Detect	7.0000E-5	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.361	Maximum Non-Detect	0.01
Variance Detects	4.9025E-4	Percent Non-Detects	7.307%
Mean Detects	0.0144	SD Detects	0.0221
Median Detects	0.00885	CV Detects	1.533
Skewness Detects	6.588	Kurtosis Detects	71.61
Mean of Logged Detects	-4.855	SD of Logged Detects	1.194

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.528	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0271	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0136	KM Standard Error of Mean	6.2844E-4
KM SD	0.0215	95% KM (BCA) UCL	0.0147
95% KM (t) UCL	0.0146	95% KM (Percentile Bootstrap) UCL	0.0146
95% KM (z) UCL	0.0146	95% KM Bootstrap t UCL	0.0148
90% KM Chebyshev UCL	0.0154	95% KM Chebyshev UCL	0.0163
97.5% KM Chebyshev UCL	0.0175	99% KM Chebyshev UCL	0.0198

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	11.43	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.787	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0916	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0289	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.942	k star (bias corrected MLE)	0.94
Theta hat (MLE)	0.0153	Theta star (bias corrected MLE)	0.0154
nu hat (MLE)	2056	nu star (bias corrected)	2052
Mean (detects)	0.0144		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.0000E-5	Mean	0.0141
Maximum	0.361	Median	0.0098
SD	0.0213	CV	1.512
k hat (MLE)	1.002	k star (bias corrected MLE)	1
Theta hat (MLE)	0.0141	Theta star (bias corrected MLE)	0.0141
nu hat (MLE)	2359	nu star (bias corrected)	2354
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	2242	Adjusted Chi Square Value (N/A, β)	2242
95% Gamma Approximate UCL (use when n>=50)	0.0148	95% Gamma Adjusted UCL (use when n<50)	0.0148

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0136	SD (KM)	0.0215
Variance (KM)	4.6422E-4	SE of Mean (KM)	6.2844E-4
k hat (KM)	0.396	k star (KM)	0.395
nu hat (KM)	931.3	nu star (KM)	930.3
theta hat (KM)	0.0343	theta star (KM)	0.0343
80% gamma percentile (KM)	0.0218	90% gamma percentile (KM)	0.0384
95% gamma percentile (KM)	0.0565	99% gamma percentile (KM)	0.102

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (930.29, α)	860.5	Adjusted Chi Square Value (930.29, β)	860.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.0147	95% Gamma Adjusted KM-UCL (use when n<50)	0.0147

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.96	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0722	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0271	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0135	Mean in Log Scale	-4.967
SD in Original Scale	0.0216	SD in Log Scale	1.233
95% t UCL (assumes normality of ROS data)	0.0146	95% Percentile Bootstrap UCL	0.0146
95% BCA Bootstrap UCL	0.0147	95% Bootstrap t UCL	0.0147
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.976	KM Geo Mean	0.0069
KM SD (logged)	1.266	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0379	95% H-UCL (KM -Log)	N/A
KM SD (logged)	1.266	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0379		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0136	Mean in Log Scale	-4.953
SD in Original Scale	0.0215	SD in Log Scale	1.218
95% t UCL (Assumes normality)	0.0146	95% H-Stat UCL	N/A

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0163

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/L)

General Statistics

Total Number of Observations	566	Number of Distinct Observations	208
Number of Detects	295	Number of Non-Detects	271
Number of Distinct Detects	203	Number of Distinct Non-Detects	6
Minimum Detect	5.9100E-4	Minimum Non-Detect	0.001
Maximum Detect	0.0612	Maximum Non-Detect	0.1
Variance Detects	2.5166E-5	Percent Non-Detects	47.88%
Mean Detects	0.00341	SD Detects	0.00502
Median Detects	0.00213	CV Detects	1.473
Skewness Detects	6.988	Kurtosis Detects	66.04
Mean of Logged Detects	-6.013	SD of Logged Detects	0.674

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.43	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.3	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.052	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00295	KM Standard Error of Mean	1.7963E-4
KM SD	0.00392	95% KM (BCA) UCL	0.00323
95% KM (t) UCL	0.00325	95% KM (Percentile Bootstrap) UCL	0.00327
95% KM (z) UCL	0.00325	95% KM Bootstrap t UCL	0.00332
90% KM Chebyshev UCL	0.00349	95% KM Chebyshev UCL	0.00374
97.5% KM Chebyshev UCL	0.00407	99% KM Chebyshev UCL	0.00474

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	19.15	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.77	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.186	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0536	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.659	k star (bias corrected MLE)	1.645
Theta hat (MLE)	0.00205	Theta star (bias corrected MLE)	0.00207
nu hat (MLE)	978.9	nu star (bias corrected)	970.3
Mean (detects)	0.00341		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.9100E-4	Mean	0.00658
Maximum	0.0612	Median	0.00993
SD	0.00491	CV	0.746
k hat (MLE)	1.743	k star (bias corrected MLE)	1.735
Theta hat (MLE)	0.00378	Theta star (bias corrected MLE)	0.00379
nu hat (MLE)	1973	nu star (bias corrected)	1963
Adjusted Level of Significance (β)	0.0496		
Approximate Chi Square Value (N/A, α)	1862	Adjusted Chi Square Value (N/A, β)	1861
95% Gamma Approximate UCL (use when n>=50)	0.00694	95% Gamma Adjusted UCL (use when n<50)	0.00694

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00295	SD (KM)	0.00392
Variance (KM)	1.5392E-5	SE of Mean (KM)	1.7963E-4
k hat (KM)	0.566	k star (KM)	0.565
nu hat (KM)	641.3	nu star (KM)	639.2
theta hat (KM)	0.00521	theta star (KM)	0.00523
80% gamma percentile (KM)	0.00487	90% gamma percentile (KM)	0.00778
95% gamma percentile (KM)	0.0109	99% gamma percentile (KM)	0.0183

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (639.21, α)	581.6	Adjusted Chi Square Value (639.21, β)	581.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.00325	95% Gamma Adjusted KM-UCL (use when n<50)	0.00325

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.052	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00297	Mean in Log Scale	-6.079
SD in Original Scale	0.00378	SD in Log Scale	0.635
95% t UCL (assumes normality of ROS data)	0.00323	95% Percentile Bootstrap UCL	0.00325
95% BCA Bootstrap UCL	0.00332	95% Bootstrap t UCL	0.00333
95% H-UCL (Log ROS)	0.00294		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.088	KM Geo Mean	0.00227
KM SD (logged)	0.609	95% Critical H Value (KM-Log)	1.848
KM Standard Error of Mean (logged)	0.0322	95% H-UCL (KM -Log)	0.00286
KM SD (logged)	0.609	95% Critical H Value (KM-Log)	1.848
KM Standard Error of Mean (logged)	0.0322		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00724	Mean in Log Scale	-5.547
SD in Original Scale	0.00972	SD in Log Scale	1.015
95% t UCL (Assumes normality)	0.00791	95% H-Stat UCL	0.00715

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.00374

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/L)

General Statistics

Total Number of Observations	963	Number of Distinct Observations	571
Number of Detects	793	Number of Non-Detects	170
Number of Distinct Detects	570	Number of Distinct Non-Detects	4
Minimum Detect	0.00123	Minimum Non-Detect	0.005
Maximum Detect	0.124	Maximum Non-Detect	0.1
Variance Detects	9.4130E-4	Percent Non-Detects	17.65%
Mean Detects	0.0311	SD Detects	0.0307
Median Detects	0.017	CV Detects	0.988
Skewness Detects	0.902	Kurtosis Detects	-0.547
Mean of Logged Detects	-4.109	SD of Logged Detects	1.241

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.817	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.192	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0318	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0275	KM Standard Error of Mean	9.5712E-4
KM SD	0.0293	95% KM (BCA) UCL	0.0292
95% KM (t) UCL	0.029	95% KM (Percentile Bootstrap) UCL	0.029
95% KM (z) UCL	0.029	95% KM Bootstrap t UCL	0.029
90% KM Chebyshev UCL	0.0303	95% KM Chebyshev UCL	0.0316
97.5% KM Chebyshev UCL	0.0334	99% KM Chebyshev UCL	0.037

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	15.44	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.789	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0943	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0347	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.916	k star (bias corrected MLE)	0.913
Theta hat (MLE)	0.0339	Theta star (bias corrected MLE)	0.034
nu hat (MLE)	1453	nu star (bias corrected)	1449
Mean (detects)	0.0311		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00123	Mean	0.0283
Maximum	0.124	Median	0.0149
SD	0.0287	CV	1.012
k hat (MLE)	1.007	k star (bias corrected MLE)	1.004
Theta hat (MLE)	0.0281	Theta star (bias corrected MLE)	0.0282
nu hat (MLE)	1939	nu star (bias corrected)	1934
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	1833	Adjusted Chi Square Value (N/A, β)	1833
95% Gamma Approximate UCL (use when n>=50)	0.0299	95% Gamma Adjusted UCL (use when n<50)	0.0299

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0275	SD (KM)	0.0293
Variance (KM)	8.5801E-4	SE of Mean (KM)	9.5712E-4
k hat (KM)	0.878	k star (KM)	0.876
nu hat (KM)	1692	nu star (KM)	1688
theta hat (KM)	0.0313	theta star (KM)	0.0313
80% gamma percentile (KM)	0.0446	90% gamma percentile (KM)	0.0653
95% gamma percentile (KM)	0.0862	99% gamma percentile (KM)	0.135

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1593	Adjusted Chi Square Value (N/A, β)	1593
95% Gamma Approximate KM-UCL (use when n>=50)	0.0291	95% Gamma Adjusted KM-UCL (use when n<50)	0.0291

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.924	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0998	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0318	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0273	Mean in Log Scale	-4.258
SD in Original Scale	0.0292	SD in Log Scale	1.229
95% t UCL (assumes normality of ROS data)	0.0289	95% Percentile Bootstrap UCL	0.0289
95% BCA Bootstrap UCL	0.0289	95% Bootstrap t UCL	0.0289
95% H-UCL (Log ROS)	0.033		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.267	KM Geo Mean	0.014
KM SD (logged)	1.242	95% Critical H Value (KM-Log)	2.301
KM Standard Error of Mean (logged)	0.0421	95% H-UCL (KM -Log)	0.0332
KM SD (logged)	1.242	95% Critical H Value (KM-Log)	2.301
KM Standard Error of Mean (logged)	0.0421		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.029	Mean in Log Scale	-4.125
SD in Original Scale	0.0285	SD in Log Scale	1.183
95% t UCL (Assumes normality)	0.0305	95% H-Stat UCL	0.0354

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0316

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/L)

General Statistics

Total Number of Observations	1165	Number of Distinct Observations	518
Number of Detects	924	Number of Non-Detects	241
Number of Distinct Detects	515	Number of Distinct Non-Detects	5

Minimum Detect	2.2200E-4	Minimum Non-Detect	0.005
Maximum Detect	0.22	Maximum Non-Detect	0.1
Variance Detects	1.0442E-4	Percent Non-Detects	20.69%
Mean Detects	0.00524	SD Detects	0.0102
Median Detects	0.00335	CV Detects	1.951
Skewness Detects	13.68	Kurtosis Detects	247.1
Mean of Logged Detects	-5.595	SD of Logged Detects	0.686

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.285	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.324	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0294	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00493	KM Standard Error of Mean	2.7389E-4
KM SD	0.00923	95% KM (BCA) UCL	0.00532
95% KM (t) UCL	0.00538	95% KM (Percentile Bootstrap) UCL	0.00541
95% KM (z) UCL	0.00538	95% KM Bootstrap t UCL	0.00563
90% KM Chebyshev UCL	0.00575	95% KM Chebyshev UCL	0.00613
97.5% KM Chebyshev UCL	0.00664	99% KM Chebyshev UCL	0.00766

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.082E+28	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.771	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.152	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.031	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.605	k star (bias corrected MLE)	1.6
Theta hat (MLE)	0.00326	Theta star (bias corrected MLE)	0.00327
nu hat (MLE)	2966	nu star (bias corrected)	2957
Mean (detects)	0.00524		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.2200E-4	Mean	0.00631
Maximum	0.22	Median	0.00407
SD	0.00937	CV	1.485
k hat (MLE)	1.723	k star (bias corrected MLE)	1.719
Theta hat (MLE)	0.00366	Theta star (bias corrected MLE)	0.00367
nu hat (MLE)	4015	nu star (bias corrected)	4005
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	3859	Adjusted Chi Square Value (N/A, β)	3859
95% Gamma Approximate UCL (use when n>=50)	0.00655	95% Gamma Adjusted UCL (use when n<50)	0.00655

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00493	SD (KM)	0.00923
Variance (KM)	8.5124E-5	SE of Mean (KM)	2.7389E-4
k hat (KM)	0.286	k star (KM)	0.286
nu hat (KM)	665.8	nu star (KM)	665.4
theta hat (KM)	0.0173	theta star (KM)	0.0173
80% gamma percentile (KM)	0.00747	90% gamma percentile (KM)	0.0146
95% gamma percentile (KM)	0.0229	99% gamma percentile (KM)	0.0446

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (665.39, α)	606.5	Adjusted Chi Square Value (665.39, β)	606.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.00541	95% Gamma Adjusted KM-UCL (use when n<50)	0.00541

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.933	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0809	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0294	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00493	Mean in Log Scale	-5.624
SD in Original Scale	0.00917	SD in Log Scale	0.664
95% t UCL (assumes normality of ROS data)	0.00537	95% Percentile Bootstrap UCL	0.00539
95% BCA Bootstrap UCL	0.00551	95% Bootstrap t UCL	0.00562
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.627	KM Geo Mean	0.0036
KM SD (logged)	0.663	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.021	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.663	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.021		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00696	Mean in Log Scale	-5.424
SD in Original Scale	0.011	SD in Log Scale	0.844
95% t UCL (Assumes normality)	0.00749	95% H-Stat UCL	N/A

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.00613

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Iron (mg/L)

General Statistics

Total Number of Observations	1221	Number of Distinct Observations	819
Number of Detects	1220	Number of Non-Detects	1
Number of Distinct Detects	818	Number of Distinct Non-Detects	1
Minimum Detect	0.01	Minimum Non-Detect	0.02
Maximum Detect	256	Maximum Non-Detect	0.02
Variance Detects	4628	Percent Non-Detects	0.0819%
Mean Detects	42.86	SD Detects	68.03
Median Detects	4.09	CV Detects	1.587
Skewness Detects	1.386	Kurtosis Detects	0.228
Mean of Logged Detects	1.859	SD of Logged Detects	2.187

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.635	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.329	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0256	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	42.83	KM Standard Error of Mean	1.946
KM SD	67.99	95% KM (BCA) UCL	45.98
95% KM (t) UCL	46.03	95% KM (Percentile Bootstrap) UCL	46.18
95% KM (z) UCL	46.03	95% KM Bootstrap t UCL	46
90% KM Chebyshev UCL	48.67	95% KM Chebyshev UCL	51.31
97.5% KM Chebyshev UCL	54.98	99% KM Chebyshev UCL	62.19

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	69.69	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.858	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0292	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.354	k star (bias corrected MLE)	0.353
Theta hat (MLE)	121.2	Theta star (bias corrected MLE)	121.3
nu hat (MLE)	862.7	nu star (bias corrected)	861.9
Mean (detects)	42.86		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	42.83
Maximum	256	Median	4.1
SD	68.01	CV	1.588
k hat (MLE)	0.354	k star (bias corrected MLE)	0.353
Theta hat (MLE)	121.1	Theta star (bias corrected MLE)	121.2
nu hat (MLE)	863.7	nu star (bias corrected)	862.9
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (862.90, α)	795.7	Adjusted Chi Square Value (862.90, β)	795.7
95% Gamma Approximate UCL (use when n>=50)	46.45	95% Gamma Adjusted UCL (use when n<50)	46.45

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	42.83	SD (KM)	67.99
Variance (KM)	4622	SE of Mean (KM)	1.946
k hat (KM)	0.397	k star (KM)	0.396
nu hat (KM)	969.1	nu star (KM)	968
theta hat (KM)	107.9	theta star (KM)	108
80% gamma percentile (KM)	69.05	90% gamma percentile (KM)	121.2
95% gamma percentile (KM)	178.5	99% gamma percentile (KM)	322.8

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (968.01, α)	896.8	Adjusted Chi Square Value (968.01, β)	896.7
95% Gamma Approximate KM-UCL (use when n>=50)	46.23	95% Gamma Adjusted KM-UCL (use when n<50)	46.23

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.91	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.111	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0256	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	42.83	Mean in Log Scale	1.854
SD in Original Scale	68.01	SD in Log Scale	2.195
95% t UCL (assumes normality of ROS data)	46.03	95% Percentile Bootstrap UCL	46.08
95% BCA Bootstrap UCL	45.97	95% Bootstrap t UCL	46.06
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.854	KM Geo Mean	6.385
KM SD (logged)	2.193	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0628	95% H-UCL (KM -Log)	N/A
KM SD (logged)	2.193	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0628		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	42.83	Mean in Log Scale	1.854
SD in Original Scale	68.01	SD in Log Scale	2.194
95% t UCL (Assumes normality)	46.03	95% H-Stat UCL	N/A

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use
95% KM (Chebyshev) UCL 51.31

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/L)

General Statistics

Total Number of Observations	967	Number of Distinct Observations	577
Number of Detects	870	Number of Non-Detects	97
Number of Distinct Detects	576	Number of Distinct Non-Detects	5
Minimum Detect	2.6000E-4	Minimum Non-Detect	2.0000E-4
Maximum Detect	1.31	Maximum Non-Detect	0.01
Variance Detects	0.00299	Percent Non-Detects	10.03%
Mean Detects	0.0405	SD Detects	0.0547
Median Detects	0.0314	CV Detects	1.352
Skewness Detects	15.15	Kurtosis Detects	337.3
Mean of Logged Detects	-3.649	SD of Logged Detects	1.07

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.452	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.231	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0303	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0368	KM Standard Error of Mean	0.0017
KM SD	0.053	95% KM (BCA) UCL	0.04
95% KM (t) UCL	0.0396	95% KM (Percentile Bootstrap) UCL	0.0398
95% KM (z) UCL	0.0396	95% KM Bootstrap t UCL	0.0412
90% KM Chebyshev UCL	0.0419	95% KM Chebyshev UCL	0.0442
97.5% KM Chebyshev UCL	0.0475	99% KM Chebyshev UCL	0.0538

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.149E+28	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.778	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0661	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.0325	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.273	k star (bias corrected MLE)	1.269
Theta hat (MLE)	0.0318	Theta star (bias corrected MLE)	0.0319
nu hat (MLE)	2215	nu star (bias corrected)	2209
Mean (detects)	0.0405		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.6000E-4	Mean	0.0374
Maximum	1.31	Median	0.0283
SD	0.0527	CV	1.408
k hat (MLE)	1.229	k star (bias corrected MLE)	1.226
Theta hat (MLE)	0.0304	Theta star (bias corrected MLE)	0.0305
nu hat (MLE)	2377	nu star (bias corrected)	2371
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	2259	Adjusted Chi Square Value (N/A, β)	2259
95% Gamma Approximate UCL (use when n>=50)	0.0393	95% Gamma Adjusted UCL (use when n<50)	0.0393

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0368	SD (KM)	0.053
Variance (KM)	0.00281	SE of Mean (KM)	0.0017
k hat (KM)	0.483	k star (KM)	0.482
nu hat (KM)	934.1	nu star (KM)	932.6
theta hat (KM)	0.0762	theta star (KM)	0.0764
80% gamma percentile (KM)	0.0604	90% gamma percentile (KM)	0.1
95% gamma percentile (KM)	0.143	99% gamma percentile (KM)	0.249

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (932.56, α)	862.7	Adjusted Chi Square Value (932.56, β)	862.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.0398	95% Gamma Adjusted KM-UCL (use when n<50)	0.0398

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.924	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0929	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0303	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0369	Mean in Log Scale	-3.819
SD in Original Scale	0.0529	SD in Log Scale	1.149
95% t UCL (assumes normality of ROS data)	0.0397	95% Percentile Bootstrap UCL	0.0398
95% BCA Bootstrap UCL	0.0411	95% Bootstrap t UCL	0.0412
95% H-UCL (Log ROS)	0.0461		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.866	KM Geo Mean	0.0209
KM SD (logged)	1.243	95% Critical H Value (KM-Log)	2.302
KM Standard Error of Mean (logged)	0.0415	95% H-UCL (KM -Log)	0.0497
KM SD (logged)	1.243	95% Critical H Value (KM-Log)	2.302
KM Standard Error of Mean (logged)	0.0415		

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0368	Mean in Log Scale	-3.834
SD in Original Scale	0.053	SD in Log Scale	1.171
95% t UCL (Assumes normality)	0.0397	95% H-Stat UCL	0.0467

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.0442

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/L)

General Statistics

Total Number of Observations	1190	Number of Distinct Observations	688
Number of Detects	1187	Number of Non-Detects	3
Number of Distinct Detects	685	Number of Distinct Non-Detects	3
Minimum Detect	0.0286	Minimum Non-Detect	0.01
Maximum Detect	12.1	Maximum Non-Detect	0.03
Variance Detects	2.105	Percent Non-Detects	0.252%
Mean Detects	1.439	SD Detects	1.451
Median Detects	1.03	CV Detects	1.009
Skewness Detects	2.268	Kurtosis Detects	6.787
Mean of Logged Detects	-0.0694	SD of Logged Detects	0.976

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.757	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.218	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.026	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.435	KM Standard Error of Mean	0.0421
KM SD	1.45	95% KM (BCA) UCL	1.508
95% KM (t) UCL	1.504	95% KM (Percentile Bootstrap) UCL	1.508
95% KM (z) UCL	1.504	95% KM Bootstrap t UCL	1.506
90% KM Chebyshev UCL	1.561	95% KM Chebyshev UCL	1.618
97.5% KM Chebyshev UCL	1.698	99% KM Chebyshev UCL	1.853

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	10.9	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.777	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.101	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.028	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.296	k star (bias corrected MLE)	1.293
Theta hat (MLE)	1.11	Theta star (bias corrected MLE)	1.112
nu hat (MLE)	3077	nu star (bias corrected)	3070
Mean (detects)	1.439		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.435
Maximum	12.1	Median	1.02
SD	1.451	CV	1.011
k hat (MLE)	1.272	k star (bias corrected MLE)	1.27
Theta hat (MLE)	1.128	Theta star (bias corrected MLE)	1.13
nu hat (MLE)	3028	nu star (bias corrected)	3021
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	2895	Adjusted Chi Square Value (N/A, β)	2895
95% Gamma Approximate UCL (use when n>=50)	1.498	95% Gamma Adjusted UCL (use when n<50)	1.498

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.435	SD (KM)	1.45
Variance (KM)	2.103	SE of Mean (KM)	0.0421
k hat (KM)	0.979	k star (KM)	0.977
nu hat (KM)	2330	nu star (KM)	2326
theta hat (KM)	1.466	theta star (KM)	1.469
80% gamma percentile (KM)	2.314	90% gamma percentile (KM)	3.323
95% gamma percentile (KM)	4.334	99% gamma percentile (KM)	6.686

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	2215	Adjusted Chi Square Value (N/A, β)	2214
95% Gamma Approximate KM-UCL (use when n>=50)	1.507	95% Gamma Adjusted KM-UCL (use when n<50)	1.507

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.975	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.485E-11	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0614	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.026	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.435	Mean in Log Scale	-0.0769
SD in Original Scale	1.451	SD in Log Scale	0.986
95% t UCL (assumes normality of ROS data)	1.504	95% Percentile Bootstrap UCL	1.503
95% BCA Bootstrap UCL	1.504	95% Bootstrap t UCL	1.507
95% H-UCL (Log ROS)	N/A		

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.0805	KM Geo Mean	0.923
KM SD (logged)	0.999	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.029	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.999	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.029		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.435	Mean in Log Scale	-0.0811
SD in Original Scale	1.451	SD in Log Scale	1.002
95% t UCL (Assumes normality)	1.504	95% H-Stat UCL	N/A

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	1.618

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/L)

General Statistics

Total Number of Observations	158	Number of Distinct Observations	9
Number of Detects	5	Number of Non-Detects	153
Number of Distinct Detects	5	Number of Distinct Non-Detects	4
Minimum Detect	2.5000E-5	Minimum Non-Detect	2.0000E-4
Maximum Detect	6.0000E-4	Maximum Non-Detect	0.001
Variance Detects	6.1585E-8	Percent Non-Detects	96.84%
Mean Detects	1.7900E-4	SD Detects	2.4816E-4
Median Detects	3.3000E-5	CV Detects	1.386
Skewness Detects	1.755	Kurtosis Detects	2.865
Mean of Logged Detects	-9.464	SD of Logged Detects	1.441

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.738	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.322	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	4.0150E-5	KM Standard Error of Mean	1.0579E-5
KM SD	7.4174E-5	95% KM (BCA) UCL	2.0597E-4
95% KM (t) UCL	5.7654E-5	95% KM (Percentile Bootstrap) UCL	7.0615E-5
95% KM (z) UCL	5.7551E-5	95% KM Bootstrap t UCL	1.0214E-4
90% KM Chebyshev UCL	7.1887E-5	95% KM Chebyshev UCL	8.6263E-5
97.5% KM Chebyshev UCL	1.0622E-4	99% KM Chebyshev UCL	1.4541E-4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.596	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.7	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.358	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.367	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.72	k star (bias corrected MLE)	0.421
Theta hat (MLE)	2.4867E-4	Theta star (bias corrected MLE)	4.2492E-4
nu hat (MLE)	7.198	nu star (bias corrected)	4.213
Mean (detects)	1.7900E-4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.5000E-5	Mean	0.00969
Maximum	0.01	Median	0.01
SD	0.00173	CV	0.178
k hat (MLE)	4.251	k star (bias corrected MLE)	4.175
Theta hat (MLE)	0.00228	Theta star (bias corrected MLE)	0.00232
nu hat (MLE)	1343	nu star (bias corrected)	1319
Adjusted Level of Significance (β)	0.0485		
Approximate Chi Square Value (N/A, α)	1236	Adjusted Chi Square Value (N/A, β)	1235
95% Gamma Approximate UCL (use when n>=50)	0.0103	95% Gamma Adjusted UCL (use when n<50)	0.0103

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	4.0150E-5	SD (KM)	7.4174E-5
Variance (KM)	5.5018E-9	SE of Mean (KM)	1.0579E-5
k hat (KM)	0.293	k star (KM)	0.292
nu hat (KM)	92.59	nu star (KM)	92.16
theta hat (KM)	1.3703E-4	theta star (KM)	1.3766E-4
80% gamma percentile (KM)	6.1134E-5	90% gamma percentile (KM)	1.1881E-4
95% gamma percentile (KM)	1.8533E-4	99% gamma percentile (KM)	3.5882E-4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (92.16, α)	71.02	Adjusted Chi Square Value (92.16, β)	70.85
95% Gamma Approximate KM-UCL (use when n>=50)	5.2099E-5	95% Gamma Adjusted KM-UCL (use when n<50)	5.2224E-5

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.819	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.323	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.2621E-5	Mean in Log Scale	-10.34
SD in Original Scale	6.8042E-5	SD in Log Scale	0.985
95% t UCL (assumes normality of ROS data)	6.1578E-5	95% Percentile Bootstrap UCL	6.1498E-5
95% BCA Bootstrap UCL	6.2614E-5	95% Bootstrap t UCL	6.4706E-5
95% H-UCL (Log ROS)	6.2087E-5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-10.4	KM Geo Mean	3.0472E-5
KM SD (logged)	0.466	95% Critical H Value (KM-Log)	1.813
KM Standard Error of Mean (logged)	0.0967	95% H-UCL (KM -Log)	3.6341E-5
KM SD (logged)	0.466	95% Critical H Value (KM-Log)	1.813
KM Standard Error of Mean (logged)	0.0967		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	3.3940E-4	Mean in Log Scale	-8.263
SD in Original Scale	1.9784E-4	SD in Log Scale	0.833
95% t UCL (Assumes normality)	3.6544E-4	95% H-Stat UCL	4.1860E-4

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 5.7654E-5

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/L)

General Statistics

Total Number of Observations	135	Number of Distinct Observations	5
Number of Detects	6	Number of Non-Detects	129
Number of Distinct Detects	1	Number of Distinct Non-Detects	4

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Molybdenum (mg/L) was not processed!

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nickel (mg/L)

General Statistics

Total Number of Observations	1138	Number of Distinct Observations	680
Number of Detects	1038	Number of Non-Detects	100
Number of Distinct Detects	680	Number of Distinct Non-Detects	4
Minimum Detect	0.00776	Minimum Non-Detect	0.01
Maximum Detect	1.1	Maximum Non-Detect	0.05
Variance Detects	0.114	Percent Non-Detects	8.787%
Mean Detects	0.317	SD Detects	0.338
Median Detects	0.121	CV Detects	1.064
Skewness Detects	0.888	Kurtosis Detects	-0.785
Mean of Logged Detects	-1.92	SD of Logged Detects	1.379

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.776	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0278	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.291	KM Standard Error of Mean	0.00988
KM SD	0.333	95% KM (BCA) UCL	0.308
95% KM (t) UCL	0.307	95% KM (Percentile Bootstrap) UCL	0.307
95% KM (z) UCL	0.307	95% KM Bootstrap t UCL	0.308
90% KM Chebyshev UCL	0.321	95% KM Chebyshev UCL	0.334
97.5% KM Chebyshev UCL	0.353	99% KM Chebyshev UCL	0.389

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	28.3	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.796	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.131	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0295	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.773	k star (bias corrected MLE)	0.771
Theta hat (MLE)	0.411	Theta star (bias corrected MLE)	0.411
nu hat (MLE)	1604	nu star (bias corrected)	1601
Mean (detects)	0.317		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	0.00776	Mean	0.293
Maximum	1.1	Median	0.105
SD	0.332	CV	1.131
k hat (MLE)	0.743	k star (bias corrected MLE)	0.742
Theta hat (MLE)	0.394	Theta star (bias corrected MLE)	0.395
nu hat (MLE)	1692	nu star (bias corrected)	1689
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	1594	Adjusted Chi Square Value (N/A, β)	1594
95% Gamma Approximate UCL (use when n>=50)	0.311	95% Gamma Adjusted UCL (use when n<50)	0.311

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.291	SD (KM)	0.333
Variance (KM)	0.111	SE of Mean (KM)	0.00988
k hat (KM)	0.762	k star (KM)	0.761
nu hat (KM)	1735	nu star (KM)	1732
theta hat (KM)	0.382	theta star (KM)	0.382
80% gamma percentile (KM)	0.477	90% gamma percentile (KM)	0.716
95% gamma percentile (KM)	0.961	99% gamma percentile (KM)	1.542

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1636	Adjusted Chi Square Value (N/A, β)	1636
95% Gamma Approximate KM-UCL (use when n>=50)	0.308	95% Gamma Adjusted KM-UCL (use when n<50)	0.308

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.914	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.11	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0278	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.291	Mean in Log Scale	-2.118
SD in Original Scale	0.333	SD in Log Scale	1.486
95% t UCL (assumes normality of ROS data)	0.307	95% Percentile Bootstrap UCL	0.308
95% BCA Bootstrap UCL	0.307	95% Bootstrap t UCL	0.308
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.115	KM Geo Mean	0.121
KM SD (logged)	1.467	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0437	95% H-UCL (KM -Log)	N/A
KM SD (logged)	1.467	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0437		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.291	Mean in Log Scale	-2.116
SD in Original Scale	0.333	SD in Log Scale	1.47
95% t UCL (Assumes normality)	0.307	95% H-Stat UCL	N/A

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use
95% KM (Chebyshev) UCL 0.334

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/L)

General Statistics

Total Number of Observations	202	Number of Distinct Observations	9
Number of Detects	7	Number of Non-Detects	195
Number of Distinct Detects	3	Number of Distinct Non-Detects	8
Minimum Detect	7.0000E-4	Minimum Non-Detect	4.0000E-4
Maximum Detect	0.003	Maximum Non-Detect	0.035
Variance Detects	4.4619E-7	Percent Non-Detects	96.53%
Mean Detects	0.00196	SD Detects	6.6797E-4
Median Detects	0.002	CV Detects	0.341
Skewness Detects	-0.667	Kurtosis Detects	3.227
Mean of Logged Detects	-6.307	SD of Logged Detects	0.449

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.768	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.383	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	6.4800E-4	KM Standard Error of Mean	9.7780E-5
KM SD	6.0788E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	8.0958E-4	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	8.0883E-4	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	9.4134E-4	95% KM Chebyshev UCL	0.00107
97.5% KM Chebyshev UCL	0.00126	99% KM Chebyshev UCL	0.00162

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.203	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.709	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.43	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.313	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.266	k star (bias corrected MLE)	4.247
Theta hat (MLE)	2.6936E-4	Theta star (bias corrected MLE)	4.6081E-4
nu hat (MLE)	101.7	nu star (bias corrected)	59.46
Mean (detects)	0.00196		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.0000E-4	Mean	0.00972
Maximum	0.01	Median	0.01
SD	0.00148	CV	0.152
k hat (MLE)	16.45	k star (bias corrected MLE)	16.21
Theta hat (MLE)	5.9082E-4	Theta star (bias corrected MLE)	5.9960E-4
nu hat (MLE)	6647	nu star (bias corrected)	6550
Adjusted Level of Significance (β)	0.0488		
Approximate Chi Square Value (N/A, α)	6363	Adjusted Chi Square Value (N/A, β)	6362
95% Gamma Approximate UCL (use when n>=50)	0.01	95% Gamma Adjusted UCL (use when n<50)	0.01

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	6.4800E-4	SD (KM)	6.0788E-4
Variance (KM)	3.6952E-7	SE of Mean (KM)	9.7780E-5
k hat (KM)	1.136	k star (KM)	1.123
nu hat (KM)	459.1	nu star (KM)	453.6
theta hat (KM)	5.7025E-4	theta star (KM)	5.7714E-4
80% gamma percentile (KM)	0.00103	90% gamma percentile (KM)	0.00145
95% gamma percentile (KM)	0.00186	99% gamma percentile (KM)	0.00282

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (453.60, α)	405.2	Adjusted Chi Square Value (453.60, β)	404.9
95% Gamma Approximate KM-UCL (use when n>=50)	7.2537E-4	95% Gamma Adjusted KM-UCL (use when n<50)	7.2595E-4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.682	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.438	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.3734E-4	Mean in Log Scale	-7.456
SD in Original Scale	5.5506E-4	SD in Log Scale	0.7
95% t UCL (assumes normality of ROS data)	8.0187E-4	95% Percentile Bootstrap UCL	8.0410E-4
95% BCA Bootstrap UCL	8.0482E-4	95% Bootstrap t UCL	8.0742E-4
95% H-UCL (Log ROS)	8.1188E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.575	KM Geo Mean	5.1320E-4
KM SD (logged)	0.573	95% Critical H Value (KM-Log)	1.842
KM Standard Error of Mean (logged)	0.0943	95% H-UCL (KM -Log)	6.5158E-4
KM SD (logged)	0.573	95% Critical H Value (KM-Log)	1.842
KM Standard Error of Mean (logged)	0.0943		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0057	Mean in Log Scale	-5.78
SD in Original Scale	0.00599	SD in Log Scale	1.24
95% t UCL (Assumes normality)	0.00639	95% H-Stat UCL	0.00819

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 8.0958E-4 KM H-UCL 6.5158E-4

95% KM (BCA) UCL N/A

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silica (as SIO2) (mg/L)

General Statistics

Total Number of Observations	94	Number of Distinct Observations	67
Number of Detects	93	Number of Non-Detects	1
Number of Distinct Detects	66	Number of Distinct Non-Detects	1
Minimum Detect	6.7	Minimum Non-Detect	0.5
Maximum Detect	44.1	Maximum Non-Detect	0.5
Variance Detects	26.33	Percent Non-Detects	1.064%
Mean Detects	14.06	SD Detects	5.131
Median Detects	13.7	CV Detects	0.365
Skewness Detects	2.809	Kurtosis Detects	12.95
Mean of Logged Detects	2.594	SD of Logged Detects	0.303

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.792	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0921	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	13.92	KM Standard Error of Mean	0.546
KM SD	5.264	95% KM (BCA) UCL	14.88
95% KM (t) UCL	14.82	95% KM (Percentile Bootstrap) UCL	14.87
95% KM (z) UCL	14.82	95% KM Bootstrap t UCL	14.92
90% KM Chebyshev UCL	15.56	95% KM Chebyshev UCL	16.3
97.5% KM Chebyshev UCL	17.33	99% KM Chebyshev UCL	19.35

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.73	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.133	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0927	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	10.25	k star (bias corrected MLE)	9.928
Theta hat (MLE)	1.372	Theta star (bias corrected MLE)	1.416
nu hat (MLE)	1907	nu star (bias corrected)	1847
Mean (detects)	14.06		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.252	Mean	13.96
Maximum	44.1	Median	13.7
SD	5.203	CV	0.373
k hat (MLE)	9.369	k star (bias corrected MLE)	9.077
Theta hat (MLE)	1.49	Theta star (bias corrected MLE)	1.538
nu hat (MLE)	1761	nu star (bias corrected)	1707
Adjusted Level of Significance (β)	0.0474		
Approximate Chi Square Value (N/A, α)	1612	Adjusted Chi Square Value (N/A, β)	1610
95% Gamma Approximate UCL (use when n>=50)	14.78	95% Gamma Adjusted UCL (use when n<50)	14.79

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	13.92	SD (KM)	5.264
Variance (KM)	27.71	SE of Mean (KM)	0.546
k hat (KM)	6.992	k star (KM)	6.775
nu hat (KM)	1314	nu star (KM)	1274
theta hat (KM)	1.991	theta star (KM)	2.054
80% gamma percentile (KM)	18.11	90% gamma percentile (KM)	21.06
95% gamma percentile (KM)	23.72	99% gamma percentile (KM)	29.26

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1192	Adjusted Chi Square Value (N/A, β)	1191
95% Gamma Approximate KM-UCL (use when n>=50)	14.87	95% Gamma Adjusted KM-UCL (use when n<50)	14.89

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.956	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0134	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0921	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	13.98	Mean in Log Scale	2.585
SD in Original Scale	5.171	SD in Log Scale	0.312
95% t UCL (assumes normality of ROS data)	14.86	95% Percentile Bootstrap UCL	14.91
95% BCA Bootstrap UCL	15	95% Bootstrap t UCL	15.06
95% H-UCL (Log ROS)	14.74		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.559	KM Geo Mean	12.92
KM SD (logged)	0.451	95% Critical H Value (KM-Log)	1.821
KM Standard Error of Mean (logged)	0.0468	95% H-UCL (KM -Log)	15.58
KM SD (logged)	0.451	95% Critical H Value (KM-Log)	1.821
KM Standard Error of Mean (logged)	0.0468		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	13.92	Mean in Log Scale	2.552
SD in Original Scale	5.299	SD in Log Scale	0.509
95% t UCL (Assumes normality)	14.82	95% H-Stat UCL	16.1

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	14.82	KM H-UCL	15.58
95% KM (BCA) UCL	14.88		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/L)

General Statistics

Total Number of Observations	198	Number of Distinct Observations	11
Number of Detects	6	Number of Non-Detects	192
Number of Distinct Detects	6	Number of Distinct Non-Detects	5
Minimum Detect	1.9000E-4	Minimum Non-Detect	3.0000E-4
Maximum Detect	6.5000E-4	Maximum Non-Detect	0.01
Variance Detects	2.8070E-8	Percent Non-Detects	96.97%
Mean Detects	4.6500E-4	SD Detects	1.6754E-4
Median Detects	5.1500E-4	CV Detects	0.36
Skewness Detects	-0.918	Kurtosis Detects	0.163
Mean of Logged Detects	-7.747	SD of Logged Detects	0.454

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.0864E-4	KM Standard Error of Mean	9.2188E-6
KM SD	7.9425E-5	95% KM (BCA) UCL	3.2159E-4
95% KM (t) UCL	2.2387E-4	95% KM (Percentile Bootstrap) UCL	3.1938E-4
95% KM (z) UCL	2.2380E-4	95% KM Bootstrap t UCL	2.2029E-4
90% KM Chebyshev UCL	2.3629E-4	95% KM Chebyshev UCL	2.4882E-4
97.5% KM Chebyshev UCL	2.6621E-4	99% KM Chebyshev UCL	3.0036E-4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.438	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.271	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.333	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.001	k star (bias corrected MLE)	3.612
Theta hat (MLE)	6.6418E-5	Theta star (bias corrected MLE)	1.2875E-4
nu hat (MLE)	84.01	nu star (bias corrected)	43.34
Mean (detects)	4.6500E-4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.9000E-4	Mean	0.00971
Maximum	0.01	Median	0.01
SD	0.00164	CV	0.169
k hat (MLE)	7.753	k star (bias corrected MLE)	7.639
Theta hat (MLE)	0.00125	Theta star (bias corrected MLE)	0.00127
nu hat (MLE)	3070	nu star (bias corrected)	3025
Adjusted Level of Significance (β)	0.0488		
Approximate Chi Square Value (N/A, α)	2898	Adjusted Chi Square Value (N/A, β)	2897
95% Gamma Approximate UCL (use when n>=50)	0.0101	95% Gamma Adjusted UCL (use when n<50)	0.0101

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.0864E-4	SD (KM)	7.9425E-5
Variance (KM)	6.3083E-9	SE of Mean (KM)	9.2188E-6
k hat (KM)	6.9	k star (KM)	6.799
nu hat (KM)	2733	nu star (KM)	2692
theta hat (KM)	3.0235E-5	theta star (KM)	3.0685E-5
80% gamma percentile (KM)	2.7131E-4	90% gamma percentile (KM)	3.1548E-4
95% gamma percentile (KM)	3.5526E-4	99% gamma percentile (KM)	4.3819E-4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	2573	Adjusted Chi Square Value (N/A, β)	2572
95% Gamma Approximate KM-UCL (use when n>=50)	2.1833E-4	95% Gamma Adjusted KM-UCL (use when n<50)	2.1840E-4

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.852	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.276	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.1282E-4	Mean in Log Scale	-8.565
SD in Original Scale	1.0439E-4	SD in Log Scale	0.469
95% t UCL (assumes normality of ROS data)	2.2508E-4	95% Percentile Bootstrap UCL	2.2546E-4
95% BCA Bootstrap UCL	2.2605E-4	95% Bootstrap t UCL	2.2594E-4
95% H-UCL (Log ROS)	2.2609E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-8.513	KM Geo Mean	2.0092E-4
KM SD (logged)	0.233	95% Critical H Value (KM-Log)	1.701
KM Standard Error of Mean (logged)	0.0271	95% H-UCL (KM -Log)	2.1234E-4
KM SD (logged)	0.233	95% Critical H Value (KM-Log)	1.701
KM Standard Error of Mean (logged)	0.0271		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00207	Mean in Log Scale	-7.102
SD in Original Scale	0.00208	SD in Log Scale	1.558
95% t UCL (Assumes normality)	0.00232	95% H-Stat UCL	0.00375

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 2.2387E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium (mg/L)

General Statistics

Total Number of Observations	158	Number of Distinct Observations	12
Number of Detects	38	Number of Non-Detects	120
Number of Distinct Detects	8	Number of Distinct Non-Detects	9
Minimum Detect	1.0000E-4	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.001	Maximum Non-Detect	0.025
Variance Detects	4.1679E-8	Percent Non-Detects	75.95%
Mean Detects	2.3158E-4	SD Detects	2.0415E-4
Median Detects	1.0000E-4	CV Detects	0.882
Skewness Detects	2.061	Kurtosis Detects	4.684
Mean of Logged Detects	-8.643	SD of Logged Detects	0.697

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.704	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.938	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.272	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.142	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.6078E-4	KM Standard Error of Mean	1.5223E-5
KM SD	1.4153E-4	95% KM (BCA) UCL	1.8761E-4
95% KM (t) UCL	1.8597E-4	95% KM (Percentile Bootstrap) UCL	1.8641E-4
95% KM (z) UCL	1.8582E-4	95% KM Bootstrap t UCL	1.9365E-4
90% KM Chebyshev UCL	2.0645E-4	95% KM Chebyshev UCL	2.2714E-4
97.5% KM Chebyshev UCL	2.5585E-4	99% KM Chebyshev UCL	3.1225E-4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.472	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.759	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.311	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.145	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.987	k star (bias corrected MLE)	1.848
Theta hat (MLE)	1.1653E-4	Theta star (bias corrected MLE)	1.2532E-4
nu hat (MLE)	151	nu star (bias corrected)	140.4
Mean (detects)	2.3158E-4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.0000E-4	Mean	0.00765
Maximum	0.01	Median	0.01
SD	0.00419	CV	0.548
k hat (MLE)	0.839	k star (bias corrected MLE)	0.827
Theta hat (MLE)	0.00912	Theta star (bias corrected MLE)	0.00925
nu hat (MLE)	265	nu star (bias corrected)	261.3
Adjusted Level of Significance (β)	0.0485		
Approximate Chi Square Value (261.33, α)	224.9	Adjusted Chi Square Value (261.33, β)	224.6
95% Gamma Approximate UCL (use when n>=50)	0.00889	95% Gamma Adjusted UCL (use when n<50)	0.0089

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.6078E-4	SD (KM)	1.4153E-4
Variance (KM)	2.0030E-8	SE of Mean (KM)	1.5223E-5
k hat (KM)	1.291	k star (KM)	1.27
nu hat (KM)	407.8	nu star (KM)	401.4
theta hat (KM)	1.2458E-4	theta star (KM)	1.2657E-4
80% gamma percentile (KM)	2.5316E-4	90% gamma percentile (KM)	3.4898E-4
95% gamma percentile (KM)	4.4310E-4	99% gamma percentile (KM)	6.5800E-4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (401.42, α)	356	Adjusted Chi Square Value (401.42, β)	355.6
95% Gamma Approximate KM-UCL (use when n>=50)	1.8131E-4	95% Gamma Adjusted KM-UCL (use when n<50)	1.8151E-4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.938	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.318	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.142	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.5207E-4	Mean in Log Scale	-9.021
SD in Original Scale	1.2753E-4	SD in Log Scale	0.651
95% t UCL (assumes normality of ROS data)	1.6885E-4	95% Percentile Bootstrap UCL	1.6908E-4
95% BCA Bootstrap UCL	1.7203E-4	95% Bootstrap t UCL	1.7281E-4
95% H-UCL (Log ROS)	1.6512E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-8.932	KM Geo Mean	1.3212E-4
KM SD (logged)	0.536	95% Critical H Value (KM-Log)	1.854
KM Standard Error of Mean (logged)	0.0614	95% H-UCL (KM -Log)	1.6508E-4
KM SD (logged)	0.536	95% Critical H Value (KM-Log)	1.854
KM Standard Error of Mean (logged)	0.0614		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00292	Mean in Log Scale	-7.536
SD in Original Scale	0.00496	SD in Log Scale	1.825
95% t UCL (Assumes normality)	0.00357	95% H-Stat UCL	0.00442

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 2.2714E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/L)

General Statistics

Total Number of Observations	158	Number of Distinct Observations	8
Number of Detects	9	Number of Non-Detects	149
Number of Distinct Detects	5	Number of Distinct Non-Detects	3

Minimum Detect	0.0059	Minimum Non-Detect	0.02
Maximum Detect	0.01	Maximum Non-Detect	0.05
Variance Detects	2.9761E-6	Percent Non-Detects	94.3%
Mean Detects	0.00721	SD Detects	0.00173
Median Detects	0.006	CV Detects	0.239
Skewness Detects	1.08	Kurtosis Detects	-0.551
Mean of Logged Detects	-4.955	SD of Logged Detects	0.223

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.741	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.314	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00721	KM Standard Error of Mean	5.7505E-4
KM SD	0.00163	95% KM (BCA) UCL	0.00824
95% KM (t) UCL	0.00816	95% KM (Percentile Bootstrap) UCL	0.00822
95% KM (z) UCL	0.00816	95% KM Bootstrap t UCL	0.0094
90% KM Chebyshev UCL	0.00894	95% KM Chebyshev UCL	0.00972
97.5% KM Chebyshev UCL	0.0108	99% KM Chebyshev UCL	0.0129

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.079	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.721	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.332	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.279	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	21.79	k star (bias corrected MLE)	14.6
Theta hat (MLE)	3.3094E-4	Theta star (bias corrected MLE)	4.9389E-4
nu hat (MLE)	392.2	nu star (bias corrected)	262.8
Mean (detects)	0.00721		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0059	Mean	0.0099
Maximum	0.0121	Median	0.01
SD	8.1045E-4	CV	0.0819
k hat (MLE)	115.9	k star (bias corrected MLE)	113.7
Theta hat (MLE)	8.5373E-5	Theta star (bias corrected MLE)	8.7022E-5
nu hat (MLE)	36635	nu star (bias corrected)	35941
Adjusted Level of Significance (β)	0.0485		
Approximate Chi Square Value (N/A, α)	35501	Adjusted Chi Square Value (N/A, β)	35497
95% Gamma Approximate UCL (use when n>=50)	0.01	95% Gamma Adjusted UCL (use when n<50)	0.01

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00721	SD (KM)	0.00163
Variance (KM)	2.6454E-6	SE of Mean (KM)	5.7505E-4
k hat (KM)	19.66	k star (KM)	19.29
nu hat (KM)	6211	nu star (KM)	6095
theta hat (KM)	3.6685E-4	theta star (KM)	3.7387E-4
80% gamma percentile (KM)	0.00854	90% gamma percentile (KM)	0.00938
95% gamma percentile (KM)	0.0101	99% gamma percentile (KM)	0.0116

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	5914	Adjusted Chi Square Value (N/A, β)	5913
95% Gamma Approximate KM-UCL (use when n>=50)	0.00743	95% Gamma Adjusted KM-UCL (use when n<50)	0.00743

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.758	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.321	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.274	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00723	Mean in Log Scale	-4.955
SD in Original Scale	0.00164	SD in Log Scale	0.225
95% t UCL (assumes normality of ROS data)	0.00744	95% Percentile Bootstrap UCL	0.00744
95% BCA Bootstrap UCL	0.00745	95% Bootstrap t UCL	0.00745
95% H-UCL (Log ROS)	0.00745		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.955	KM Geo Mean	0.00705
KM SD (logged)	0.21	95% Critical H Value (KM-Log)	1.701
KM Standard Error of Mean (logged)	0.0742	95% H-UCL (KM -Log)	0.00741
KM SD (logged)	0.21	95% Critical H Value (KM-Log)	1.701
KM Standard Error of Mean (logged)	0.0742		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0161	Mean in Log Scale	-4.194
SD in Original Scale	0.00566	SD in Log Scale	0.363
95% t UCL (Assumes normality)	0.0168	95% H-Stat UCL	0.017

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00816	KM H-UCL	0.00741
95% KM (BCA) UCL	0.00824		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Zinc (mg/L)

General Statistics

Total Number of Observations	1388	Number of Distinct Observations	806
Number of Detects	1386	Number of Non-Detects	2
Number of Distinct Detects	806	Number of Distinct Non-Detects	1
Minimum Detect	0.0186	Minimum Non-Detect	0.02
Maximum Detect	63.4	Maximum Non-Detect	0.02
Variance Detects	31.07	Percent Non-Detects	0.144%
Mean Detects	5.65	SD Detects	5.574
Median Detects	4.45	CV Detects	0.987
Skewness Detects	4.075	Kurtosis Detects	29.85
Mean of Logged Detects	1.232	SD of Logged Detects	1.262

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.717	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.156	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.024	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.642	KM Standard Error of Mean	0.15
KM SD	5.572	95% KM (BCA) UCL	5.902
95% KM (t) UCL	5.888	95% KM (Percentile Bootstrap) UCL	5.911
95% KM (z) UCL	5.888	95% KM Bootstrap t UCL	5.918
90% KM Chebyshev UCL	6.091	95% KM Chebyshev UCL	6.294
97.5% KM Chebyshev UCL	6.576	99% KM Chebyshev UCL	7.13

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	11.53	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.781	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0603	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0267	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.139	k star (bias corrected MLE)	1.137
Theta hat (MLE)	4.96	Theta star (bias corrected MLE)	4.969
nu hat (MLE)	3157	nu star (bias corrected)	3152
Mean (detects)	5.65		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	5.642
Maximum	63.4	Median	4.445
SD	5.574	CV	0.988
k hat (MLE)	1.125	k star (bias corrected MLE)	1.123
Theta hat (MLE)	5.016	Theta star (bias corrected MLE)	5.024
nu hat (MLE)	3123	nu star (bias corrected)	3117
Adjusted Level of Significance (β)	0.0498		
Approximate Chi Square Value (N/A, α)	2988	Adjusted Chi Square Value (N/A, β)	2988
95% Gamma Approximate UCL (use when n>=50)	5.885	95% Gamma Adjusted UCL (use when n<50)	5.885

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.642	SD (KM)	5.572
Variance (KM)	31.05	SE of Mean (KM)	0.15
k hat (KM)	1.025	k star (KM)	1.023
nu hat (KM)	2845	nu star (KM)	2841
theta hat (KM)	5.504	theta star (KM)	5.513
80% gamma percentile (KM)	9.063	90% gamma percentile (KM)	12.92
95% gamma percentile (KM)	16.76	99% gamma percentile (KM)	25.68

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	2718	Adjusted Chi Square Value (N/A, β)	2718
95% Gamma Approximate KM-UCL (use when n>=50)	5.897	95% Gamma Adjusted KM-UCL (use when n<50)	5.897

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.855	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.024	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.642	Mean in Log Scale	1.227
SD in Original Scale	5.574	SD in Log Scale	1.269
95% t UCL (assumes normality of ROS data)	5.888	95% Percentile Bootstrap UCL	5.893
95% BCA Bootstrap UCL	5.901	95% Bootstrap t UCL	5.905
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.225	KM Geo Mean	3.403
KM SD (logged)	1.276	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0343	95% H-UCL (KM -Log)	N/A
KM SD (logged)	1.276	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0343		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	5.642	Mean in Log Scale	1.224
SD in Original Scale	5.574	SD in Log Scale	1.281
95% t UCL (Assumes normality)	5.888	95% H-Stat UCL	N/A

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 14. ProUCL Output - Tar Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 6.294

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 5:01:40 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/L)

General Statistics

Total Number of Observations	40	Number of Distinct Observations	40
		Number of Missing Observations	0
Minimum	0.064	Mean	5.825
Maximum	39.6	Median	1.695
SD	8.978	Std. Error of Mean	1.42
Coefficient of Variation	1.541	Skewness	2.48

Normal GOF Test

Shapiro Wilk Test Statistic	0.656	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.264	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.139	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8.217	95% Adjusted-CLT UCL (Chen-1995)	8.755
		95% Modified-t UCL (Johnson-1978)	8.309

Gamma GOF Test

A-D Test Statistic	0.643	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.806	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.139	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.147	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.573	k star (bias corrected MLE)	0.547
Theta hat (MLE)	10.16	Theta star (bias corrected MLE)	10.65
nu hat (MLE)	45.85	nu star (bias corrected)	43.75
MLE Mean (bias corrected)	5.825	MLE Sd (bias corrected)	7.877
		Approximate Chi Square Value (0.05)	29.58
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	29.14

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	8.615	95% Adjusted Gamma UCL (use when n<50)	8.744

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.082	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.139	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.749	Mean of logged Data	0.677
Maximum of Logged Data	3.679	SD of logged Data	1.642

Assuming Lognormal Distribution

95% H-UCL	17.79	90% Chebyshev (MVUE) UCL	14.37
95% Chebyshev (MVUE) UCL	17.69	97.5% Chebyshev (MVUE) UCL	22.3
99% Chebyshev (MVUE) UCL	31.35		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8.16	95% Jackknife UCL	8.217
95% Standard Bootstrap UCL	8.219	95% Bootstrap-t UCL	9.504
95% Hall's Bootstrap UCL	9.283	95% Percentile Bootstrap UCL	8.187
95% BCA Bootstrap UCL	8.785		
90% Chebyshev(Mean, Sd) UCL	10.08	95% Chebyshev(Mean, Sd) UCL	12.01
97.5% Chebyshev(Mean, Sd) UCL	14.69	99% Chebyshev(Mean, Sd) UCL	19.95

Suggested UCL to Use

95% Adjusted Gamma UCL 8.744

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/L)

General Statistics

Total Number of Observations	31	Number of Distinct Observations	7
Number of Detects	6	Number of Non-Detects	25
Number of Distinct Detects	5	Number of Distinct Non-Detects	2
Minimum Detect	8.0000E-4	Minimum Non-Detect	0.005
Maximum Detect	0.014	Maximum Non-Detect	0.01
Variance Detects	3.1959E-5	Percent Non-Detects	80.65%
Mean Detects	0.00533	SD Detects	0.00565
Median Detects	0.0021	CV Detects	1.06
Skewness Detects	1.055	Kurtosis Detects	-1.153
Mean of Logged Detects	-5.743	SD of Logged Detects	1.114

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.759	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.383	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00244	KM Standard Error of Mean	5.9584E-4
KM SD	0.00272	95% KM (BCA) UCL	0.00348
95% KM (t) UCL	0.00345	95% KM (Percentile Bootstrap) UCL	0.00345
95% KM (z) UCL	0.00342	95% KM Bootstrap t UCL	0.0042
90% KM Chebyshev UCL	0.00423	95% KM Chebyshev UCL	0.00504
97.5% KM Chebyshev UCL	0.00616	99% KM Chebyshev UCL	0.00837

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.66	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.713	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.365	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.34	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.12	k star (bias corrected MLE)	0.671
Theta hat (MLE)	0.00476	Theta star (bias corrected MLE)	0.00795
nu hat (MLE)	13.44	nu star (bias corrected)	8.053
Mean (detects)	0.00533		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.0000E-4	Mean	0.0091
Maximum	0.014	Median	0.01
SD	0.00297	CV	0.327
k hat (MLE)	4.144	k star (bias corrected MLE)	3.764
Theta hat (MLE)	0.0022	Theta star (bias corrected MLE)	0.00242
nu hat (MLE)	256.9	nu star (bias corrected)	233.4
Adjusted Level of Significance (β)	0.0413		
Approximate Chi Square Value (233.39, α)	199	Adjusted Chi Square Value (233.39, β)	197.3
95% Gamma Approximate UCL (use when n>=50)	0.0107	95% Gamma Adjusted UCL (use when n<50)	0.0108

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00244	SD (KM)	0.00272
Variance (KM)	7.4028E-6	SE of Mean (KM)	5.9584E-4
k hat (KM)	0.807	k star (KM)	0.75
nu hat (KM)	50.01	nu star (KM)	46.5
theta hat (KM)	0.00303	theta star (KM)	0.00326
80% gamma percentile (KM)	0.00401	90% gamma percentile (KM)	0.00603
95% gamma percentile (KM)	0.00811	99% gamma percentile (KM)	0.013

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (46.50, α)	31.85	Adjusted Chi Square Value (46.50, β)	31.18
95% Gamma Approximate KM-UCL (use when n>=50)	0.00357	95% Gamma Adjusted KM-UCL (use when n<50)	0.00364

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.315	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00279	Mean in Log Scale	-6.255
SD in Original Scale	0.00297	SD in Log Scale	0.85
95% t UCL (assumes normality of ROS data)	0.0037	95% Percentile Bootstrap UCL	0.00375
95% BCA Bootstrap UCL	0.00396	95% Bootstrap t UCL	0.00434
95% H-UCL (Log ROS)	0.00391		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.288	KM Geo Mean	0.00186
KM SD (logged)	0.639	95% Critical H Value (KM-Log)	2.044
KM Standard Error of Mean (logged)	0.233	95% H-UCL (KM -Log)	0.00289
KM SD (logged)	0.639	95% Critical H Value (KM-Log)	2.044
KM Standard Error of Mean (logged)	0.233		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00498	Mean in Log Scale	-5.407
SD in Original Scale	0.00236	SD in Log Scale	0.5
95% t UCL (Assumes normality)	0.0057	95% H-Stat UCL	0.00606

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.00364

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Barium (mg/L)

General Statistics

Total Number of Observations	27	Number of Distinct Observations	23
Number of Detects	23	Number of Non-Detects	4
Number of Distinct Detects	22	Number of Distinct Non-Detects	1
Minimum Detect	0.0539	Minimum Non-Detect	0.2
Maximum Detect	0.4	Maximum Non-Detect	0.2
Variance Detects	0.00607	Percent Non-Detects	14.81%
Mean Detects	0.138	SD Detects	0.0779
Median Detects	0.117	CV Detects	0.565
Skewness Detects	2.18	Kurtosis Detects	5.358
Mean of Logged Detects	-2.094	SD of Logged Detects	0.456

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.765	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.287	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.134	KM Standard Error of Mean	0.0144
KM SD	0.072	95% KM (BCA) UCL	0.159
95% KM (t) UCL	0.159	95% KM (Percentile Bootstrap) UCL	0.16
95% KM (z) UCL	0.158	95% KM Bootstrap t UCL	0.171
90% KM Chebyshev UCL	0.177	95% KM Chebyshev UCL	0.197
97.5% KM Chebyshev UCL	0.224	99% KM Chebyshev UCL	0.278

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.908	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.747	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.226	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.182	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.638	k star (bias corrected MLE)	4.062
Theta hat (MLE)	0.0297	Theta star (bias corrected MLE)	0.0339
nu hat (MLE)	213.3	nu star (bias corrected)	186.8
Mean (detects)	0.138		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0539	Mean	0.135
Maximum	0.4	Median	0.117
SD	0.0736	CV	0.547
k hat (MLE)	4.919	k star (bias corrected MLE)	4.397
Theta hat (MLE)	0.0274	Theta star (bias corrected MLE)	0.0306
nu hat (MLE)	265.6	nu star (bias corrected)	237.4
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (237.43, α)	202.8	Adjusted Chi Square Value (237.43, β)	200.7
95% Gamma Approximate UCL (use when n>=50)	0.158	95% Gamma Adjusted UCL (use when n<50)	0.159

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.134	SD (KM)	0.072
Variance (KM)	0.00518	SE of Mean (KM)	0.0144
k hat (KM)	3.468	k star (KM)	3.107
nu hat (KM)	187.3	nu star (KM)	167.8
theta hat (KM)	0.0387	theta star (KM)	0.0432
80% gamma percentile (KM)	0.19	90% gamma percentile (KM)	0.236
95% gamma percentile (KM)	0.279	99% gamma percentile (KM)	0.371

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (167.78, α)	138.8	Adjusted Chi Square Value (167.78, β)	137.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.162	95% Gamma Adjusted KM-UCL (use when n<50)	0.164

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.134	Mean in Log Scale	-2.108
SD in Original Scale	0.073	SD in Log Scale	0.433
95% t UCL (assumes normality of ROS data)	0.158	95% Percentile Bootstrap UCL	0.159
95% BCA Bootstrap UCL	0.163	95% Bootstrap t UCL	0.172
95% H-UCL (Log ROS)	0.157		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.113	KM Geo Mean	0.121
KM SD (logged)	0.429	95% Critical H Value (KM-Log)	1.913
KM Standard Error of Mean (logged)	0.0879	95% H-UCL (KM -Log)	0.156
KM SD (logged)	0.429	95% Critical H Value (KM-Log)	1.913
KM Standard Error of Mean (logged)	0.0879		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.132	Mean in Log Scale	-2.125
SD in Original Scale	0.073	SD in Log Scale	0.426
95% t UCL (Assumes normality)	0.156	95% H-Stat UCL	0.153

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM Student's t	0.15	KM H-UCL	0.156

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/L)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	6
Number of Detects	4	Number of Non-Detects	58
Number of Distinct Detects	4	Number of Distinct Non-Detects	4
Minimum Detect	5.0000E-4	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.0017	Maximum Non-Detect	0.005
Variance Detects	2.4603E-7	Percent Non-Detects	93.55%
Mean Detects	0.0011	SD Detects	4.9601E-4
Median Detects	0.0011	CV Detects	0.452
Skewness Detects	0.0288	Kurtosis Detects	0.785
Mean of Logged Detects	-6.905	SD of Logged Detects	0.514

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.994	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.176	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.4844E-4	KM Standard Error of Mean	8.1574E-5
KM SD	3.6730E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	3.8468E-4	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	3.8261E-4	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.9316E-4	95% KM Chebyshev UCL	6.0401E-4
97.5% KM Chebyshev UCL	7.5786E-4	99% KM Chebyshev UCL	0.00106

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.241	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.219	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.706	k star (bias corrected MLE)	1.593
Theta hat (MLE)	1.9234E-4	Theta star (bias corrected MLE)	6.8886E-4
nu hat (MLE)	45.65	nu star (bias corrected)	12.75
Mean (detects)	0.0011		

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.0000E-4	Mean	0.00943
Maximum	0.01	Median	0.01
SD	0.00221	CV	0.234
k hat (MLE)	5.766	k star (bias corrected MLE)	5.497
Theta hat (MLE)	0.00163	Theta star (bias corrected MLE)	0.00171
nu hat (MLE)	715	nu star (bias corrected)	681.7
Adjusted Level of Significance (β)	0.0461		
Approximate Chi Square Value (681.69, α)	622.1	Adjusted Chi Square Value (681.69, β)	620.8
95% Gamma Approximate UCL (use when n>=50)	0.0103	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.4844E-4	SD (KM)	3.6730E-4
Variance (KM)	1.3491E-7	SE of Mean (KM)	8.1574E-5
k hat (KM)	0.458	k star (KM)	0.446
nu hat (KM)	56.73	nu star (KM)	55.32
theta hat (KM)	5.4302E-4	theta star (KM)	5.5688E-4
80% gamma percentile (KM)	4.0522E-4	90% gamma percentile (KM)	6.8769E-4
95% gamma percentile (KM)	9.9368E-4	99% gamma percentile (KM)	0.00175

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (55.32, α)	39.23	Adjusted Chi Square Value (55.32, β)	38.9
95% Gamma Approximate KM-UCL (use when n>=50)	3.5035E-4	95% Gamma Adjusted KM-UCL (use when n<50)	3.5326E-4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.248	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.5382E-4	Mean in Log Scale	-8.978
SD in Original Scale	3.4862E-4	SD in Log Scale	1.204
95% t UCL (assumes normality of ROS data)	3.2777E-4	95% Percentile Bootstrap UCL	3.3016E-4
95% BCA Bootstrap UCL	3.4622E-4	95% Bootstrap t UCL	3.5389E-4
95% H-UCL (Log ROS)	3.6960E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-8.827	KM Geo Mean	1.4678E-4
KM SD (logged)	0.834	95% Critical H Value (KM-Log)	2.12
KM Standard Error of Mean (logged)	0.214	95% H-UCL (KM -Log)	2.6064E-4
KM SD (logged)	0.834	95% Critical H Value (KM-Log)	2.12
KM Standard Error of Mean (logged)	0.214		

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00146	Mean in Log Scale	-6.956
SD in Original Scale	0.00104	SD in Log Scale	1.097
95% t UCL (Assumes normality)	0.00168	95% H-Stat UCL	0.0024

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 3.8468E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/L)

General Statistics

Total Number of Observations	36	Number of Distinct Observations	18
Number of Detects	16	Number of Non-Detects	20
Number of Distinct Detects	15	Number of Distinct Non-Detects	3
Minimum Detect	0.00126	Minimum Non-Detect	0.0011
Maximum Detect	0.041	Maximum Non-Detect	0.01
Variance Detects	1.4165E-4	Percent Non-Detects	55.56%
Mean Detects	0.0123	SD Detects	0.0119
Median Detects	0.0091	CV Detects	0.967
Skewness Detects	1.294	Kurtosis Detects	1.084
Mean of Logged Detects	-4.937	SD of Logged Detects	1.184

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.846	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00628	KM Standard Error of Mean	0.00163
KM SD	0.00942	95% KM (BCA) UCL	0.00925
95% KM (t) UCL	0.00903	95% KM (Percentile Bootstrap) UCL	0.00905
95% KM (z) UCL	0.00896	95% KM Bootstrap t UCL	0.01
90% KM Chebyshev UCL	0.0112	95% KM Chebyshev UCL	0.0134
97.5% KM Chebyshev UCL	0.0164	99% KM Chebyshev UCL	0.0225

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.448	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.186	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.221	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.061	k star (bias corrected MLE)	0.904
Theta hat (MLE)	0.0116	Theta star (bias corrected MLE)	0.0136
nu hat (MLE)	33.96	nu star (bias corrected)	28.93
Mean (detects)	0.0123		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00126	Mean	0.011
Maximum	0.041	Median	0.01
SD	0.00788	CV	0.714
k hat (MLE)	2.189	k star (bias corrected MLE)	2.025
Theta hat (MLE)	0.00504	Theta star (bias corrected MLE)	0.00544
nu hat (MLE)	157.6	nu star (bias corrected)	145.8
Adjusted Level of Significance (β)	0.0428		
Approximate Chi Square Value (145.83, α)	118.9	Adjusted Chi Square Value (145.83, β)	117.8
95% Gamma Approximate UCL (use when n>=50)	0.0135	95% Gamma Adjusted UCL (use when n<50)	0.0136

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00628	SD (KM)	0.00942
Variance (KM)	8.8688E-5	SE of Mean (KM)	0.00163
k hat (KM)	0.445	k star (KM)	0.426
nu hat (KM)	32.03	nu star (KM)	30.7
theta hat (KM)	0.0141	theta star (KM)	0.0147
80% gamma percentile (KM)	0.0102	90% gamma percentile (KM)	0.0175
95% gamma percentile (KM)	0.0255	99% gamma percentile (KM)	0.0455

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (30.70, α)	19.04	Adjusted Chi Square Value (30.70, β)	18.62
95% Gamma Approximate KM-UCL (use when n>=50)	0.0101	95% Gamma Adjusted KM-UCL (use when n<50)	0.0104

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.903	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0061	Mean in Log Scale	-6.216
SD in Original Scale	0.00965	SD in Log Scale	1.588
95% t UCL (assumes normality of ROS data)	0.00881	95% Percentile Bootstrap UCL	0.00889
95% BCA Bootstrap UCL	0.00959	95% Bootstrap t UCL	0.0104
95% H-UCL (Log ROS)	0.0163		

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.873	KM Geo Mean	0.00282
KM SD (logged)	1.161	95% Critical H Value (KM-Log)	2.571
KM Standard Error of Mean (logged)	0.206	95% H-UCL (KM -Log)	0.00915
KM SD (logged)	1.161	95% Critical H Value (KM-Log)	2.571
KM Standard Error of Mean (logged)	0.206		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00692	Mean in Log Scale	-5.614
SD in Original Scale	0.00926	SD in Log Scale	1.131
95% t UCL (Assumes normality)	0.00953	95% H-Stat UCL	0.0112

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.00903

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/L)

General Statistics

Total Number of Observations	23	Number of Distinct Observations	7
Number of Detects	5	Number of Non-Detects	18
Number of Distinct Detects	4	Number of Distinct Non-Detects	4
Minimum Detect	0.0012	Minimum Non-Detect	6.0000E-4
Maximum Detect	0.02	Maximum Non-Detect	0.05
Variance Detects	5.9472E-5	Percent Non-Detects	78.26%
Mean Detects	0.00728	SD Detects	0.00771
Median Detects	0.006	CV Detects	1.059
Skewness Detects	1.46	Kurtosis Detects	2.219
Mean of Logged Detects	-5.461	SD of Logged Detects	1.237

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.84	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.263	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00259	KM Standard Error of Mean	0.00118
KM SD	0.00455	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00461	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.00452	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00612	95% KM Chebyshev UCL	0.00773
97.5% KM Chebyshev UCL	0.00995	99% KM Chebyshev UCL	0.0143

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.356	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.691	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.26	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.364	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.064	k star (bias corrected MLE)	0.559
Theta hat (MLE)	0.00684	Theta star (bias corrected MLE)	0.013
nu hat (MLE)	10.64	nu star (bias corrected)	5.588
Mean (detects)	0.00728		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0012	Mean	0.00941
Maximum	0.02	Median	0.01
SD	0.00348	CV	0.37
k hat (MLE)	4.153	k star (bias corrected MLE)	3.64
Theta hat (MLE)	0.00227	Theta star (bias corrected MLE)	0.00258
nu hat (MLE)	191	nu star (bias corrected)	167.5
Adjusted Level of Significance (β)	0.0389		
Approximate Chi Square Value (167.46, α)	138.5	Adjusted Chi Square Value (167.46, β)	136.6
95% Gamma Approximate UCL (use when n>=50)	0.0114	95% Gamma Adjusted UCL (use when n<50)	0.0115

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00259	SD (KM)	0.00455
Variance (KM)	2.0695E-5	SE of Mean (KM)	0.00118
k hat (KM)	0.323	k star (KM)	0.31
nu hat (KM)	14.85	nu star (KM)	14.25
theta hat (KM)	0.00801	theta star (KM)	0.00834
80% gamma percentile (KM)	0.00399	90% gamma percentile (KM)	0.00759
95% gamma percentile (KM)	0.0117	99% gamma percentile (KM)	0.0223

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (14.25, α)	6.743	Adjusted Chi Square Value (14.25, β)	6.371
95% Gamma Approximate KM-UCL (use when n>=50)	0.00546	95% Gamma Adjusted KM-UCL (use when n<50)	0.00578

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.886	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.247	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00223	Mean in Log Scale	-7.175
SD in Original Scale	0.00434	SD in Log Scale	1.457
95% t UCL (assumes normality of ROS data)	0.00378	95% Percentile Bootstrap UCL	0.00374
95% BCA Bootstrap UCL	0.00483	95% Bootstrap t UCL	0.00603
95% H-UCL (Log ROS)	0.00594		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.672	KM Geo Mean	0.00127
KM SD (logged)	0.98	95% Critical H Value (KM-Log)	2.499
KM Standard Error of Mean (logged)	0.291	95% H-UCL (KM -Log)	0.00345
KM SD (logged)	0.98	95% Critical H Value (KM-Log)	2.499
KM Standard Error of Mean (logged)	0.291		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00759	Mean in Log Scale	-5.6
SD in Original Scale	0.00916	SD in Log Scale	1.281
95% t UCL (Assumes normality)	0.0109	95% H-Stat UCL	0.0186

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.00461

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/L)

General Statistics

Total Number of Observations	40	Number of Distinct Observations	26
Number of Detects	27	Number of Non-Detects	13
Number of Distinct Detects	24	Number of Distinct Non-Detects	2
Minimum Detect	9.0000E-4	Minimum Non-Detect	0.005
Maximum Detect	0.0452	Maximum Non-Detect	0.02
Variance Detects	1.8686E-4	Percent Non-Detects	32.5%
Mean Detects	0.0126	SD Detects	0.0137
Median Detects	0.0061	CV Detects	1.087
Skewness Detects	1.456	Kurtosis Detects	0.783
Mean of Logged Detects	-4.89	SD of Logged Detects	1.029

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.739	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.923	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.29	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.167	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00951	KM Standard Error of Mean	0.00192
KM SD	0.0119	95% KM (BCA) UCL	0.0126
95% KM (t) UCL	0.0127	95% KM (Percentile Bootstrap) UCL	0.0128
95% KM (z) UCL	0.0127	95% KM Bootstrap t UCL	0.0138
90% KM Chebyshev UCL	0.0153	95% KM Chebyshev UCL	0.0179
97.5% KM Chebyshev UCL	0.0215	99% KM Chebyshev UCL	0.0286

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.224	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.771	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.199	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.173	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.11	k star (bias corrected MLE)	1.011
Theta hat (MLE)	0.0113	Theta star (bias corrected MLE)	0.0124
nu hat (MLE)	59.95	nu star (bias corrected)	54.62
Mean (detects)	0.0126		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	9.0000E-4	Mean	0.0117
Maximum	0.0452	Median	0.01
SD	0.0112	CV	0.956
k hat (MLE)	1.565	k star (bias corrected MLE)	1.464
Theta hat (MLE)	0.0075	Theta star (bias corrected MLE)	0.00802
nu hat (MLE)	125.2	nu star (bias corrected)	117.1
Adjusted Level of Significance (β)	0.044		
Approximate Chi Square Value (117.11, α)	93.12	Adjusted Chi Square Value (117.11, β)	92.32
95% Gamma Approximate UCL (use when n>=50)	0.0148	95% Gamma Adjusted UCL (use when n<50)	0.0149

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00951	SD (KM)	0.0119
Variance (KM)	1.4162E-4	SE of Mean (KM)	0.00192
k hat (KM)	0.638	k star (KM)	0.607
nu hat (KM)	51.07	nu star (KM)	48.58
theta hat (KM)	0.0149	theta star (KM)	0.0157
80% gamma percentile (KM)	0.0157	90% gamma percentile (KM)	0.0247
95% gamma percentile (KM)	0.0341	99% gamma percentile (KM)	0.0568

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (48.58, α)	33.58	Adjusted Chi Square Value (48.58, β)	33.11
95% Gamma Approximate KM-UCL (use when n>=50)	0.0138	95% Gamma Adjusted KM-UCL (use when n<50)	0.014

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.129	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0095	Mean in Log Scale	-5.22
SD in Original Scale	0.0121	SD in Log Scale	1.02
95% t UCL (assumes normality of ROS data)	0.0127	95% Percentile Bootstrap UCL	0.0128
95% BCA Bootstrap UCL	0.0132	95% Bootstrap t UCL	0.0138
95% H-UCL (Log ROS)	0.0135		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.204	KM Geo Mean	0.0055
KM SD (logged)	0.98	95% Critical H Value (KM-Log)	2.385
KM Standard Error of Mean (logged)	0.169	95% H-UCL (KM -Log)	0.0129
KM SD (logged)	0.98	95% Critical H Value (KM-Log)	2.385
KM Standard Error of Mean (logged)	0.169		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00949	Mean in Log Scale	-5.213
SD in Original Scale	0.0121	SD in Log Scale	0.987
95% t UCL (Assumes normality)	0.0127	95% H-Stat UCL	0.0129

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.0129

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/L)

General Statistics

Total Number of Observations	35	Number of Distinct Observations	35
Number of Detects	34	Number of Non-Detects	1
Number of Distinct Detects	34	Number of Distinct Non-Detects	1

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	0.179	Minimum Non-Detect	0.02
Maximum Detect	26.6	Maximum Non-Detect	0.02
Variance Detects	35.55	Percent Non-Detects	2.857%
Mean Detects	4.617	SD Detects	5.962
Median Detects	2.18	CV Detects	1.291
Skewness Detects	2.188	Kurtosis Detects	5.277
Mean of Logged Detects	0.727	SD of Logged Detects	1.388

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.732	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.15	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	4.486	KM Standard Error of Mean	1.002
KM SD	5.84	95% KM (BCA) UCL	6.278
95% KM (t) UCL	6.18	95% KM (Percentile Bootstrap) UCL	6.184
95% KM (z) UCL	6.134	95% KM Bootstrap t UCL	6.849
90% KM Chebyshev UCL	7.492	95% KM Chebyshev UCL	8.853
97.5% KM Chebyshev UCL	10.74	99% KM Chebyshev UCL	14.45

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.516	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.788	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.157	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.746	k star (bias corrected MLE)	0.7
Theta hat (MLE)	6.19	Theta star (bias corrected MLE)	6.599
nu hat (MLE)	50.72	nu star (bias corrected)	47.58
Mean (detects)	4.617		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	4.485
Maximum	26.6	Median	2.01
SD	5.925	CV	1.321
k hat (MLE)	0.658	k star (bias corrected MLE)	0.621
Theta hat (MLE)	6.817	Theta star (bias corrected MLE)	7.227
nu hat (MLE)	46.06	nu star (bias corrected)	43.44
Adjusted Level of Significance (β)	0.0425		
Approximate Chi Square Value (43.44, α)	29.33	Adjusted Chi Square Value (43.44, β)	28.78
95% Gamma Approximate UCL (use when n>=50)	6.644	95% Gamma Adjusted UCL (use when n<50)	6.771

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	4.486	SD (KM)	5.84
Variance (KM)	34.1	SE of Mean (KM)	1.002
k hat (KM)	0.59	k star (KM)	0.559
nu hat (KM)	41.31	nu star (KM)	39.1
theta hat (KM)	7.602	theta star (KM)	8.031
80% gamma percentile (KM)	7.391	90% gamma percentile (KM)	11.85
95% gamma percentile (KM)	16.56	99% gamma percentile (KM)	28.02

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (39.10, α)	25.78	Adjusted Chi Square Value (39.10, β)	25.26
95% Gamma Approximate KM-UCL (use when n>=50)	6.804	95% Gamma Adjusted KM-UCL (use when n<50)	6.943

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0948	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.15	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.487	Mean in Log Scale	0.626
SD in Original Scale	5.924	SD in Log Scale	1.493
95% t UCL (assumes normality of ROS data)	6.18	95% Percentile Bootstrap UCL	6.148
95% BCA Bootstrap UCL	6.53	95% Bootstrap t UCL	6.845
95% H-UCL (Log ROS)	12.66		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.594	KM Geo Mean	1.811
KM SD (logged)	1.554	95% Critical H Value (KM-Log)	3.211
KM Standard Error of Mean (logged)	0.267	95% H-UCL (KM -Log)	14.26
KM SD (logged)	1.554	95% Critical H Value (KM-Log)	3.211
KM Standard Error of Mean (logged)	0.267		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	4.485	Mean in Log Scale	0.574
SD in Original Scale	5.925	SD in Log Scale	1.638
95% t UCL (Assumes normality)	6.179	95% H-Stat UCL	17.33

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

ısted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	6.943

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lead (mg/L)

General Statistics

Total Number of Observations	59	Number of Distinct Observations	12
Number of Detects	11	Number of Non-Detects	48
Number of Distinct Detects	10	Number of Distinct Non-Detects	3
Minimum Detect	4.0000E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.021	Maximum Non-Detect	0.01
Variance Detects	6.2519E-5	Percent Non-Detects	81.36%
Mean Detects	0.00881	SD Detects	0.00791
Median Detects	0.005	CV Detects	0.898
Skewness Detects	0.439	Kurtosis Detects	-1.621
Mean of Logged Detects	-5.336	SD of Logged Detects	1.339

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.238	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00258	KM Standard Error of Mean	6.7881E-4
KM SD	0.00452	95% KM (BCA) UCL	0.0037
95% KM (t) UCL	0.00372	95% KM (Percentile Bootstrap) UCL	0.00369
95% KM (z) UCL	0.0037	95% KM Bootstrap t UCL	0.00387
90% KM Chebyshev UCL	0.00462	95% KM Chebyshev UCL	0.00554
97.5% KM Chebyshev UCL	0.00682	99% KM Chebyshev UCL	0.00934

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.496	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.225	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.263	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.96	k star (bias corrected MLE)	0.759
Theta hat (MLE)	0.00917	Theta star (bias corrected MLE)	0.0116
nu hat (MLE)	21.13	nu star (bias corrected)	16.7
Mean (detects)	0.00881		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.0000E-4	Mean	0.00978
Maximum	0.021	Median	0.01
SD	0.00332	CV	0.339
k hat (MLE)	4.555	k star (bias corrected MLE)	4.334
Theta hat (MLE)	0.00215	Theta star (bias corrected MLE)	0.00226
nu hat (MLE)	537.4	nu star (bias corrected)	511.4
Adjusted Level of Significance (β)	0.0459		
Approximate Chi Square Value (511.44, α)	460	Adjusted Chi Square Value (511.44, β)	458.8
95% Gamma Approximate UCL (use when n>=50)	0.0109	95% Gamma Adjusted UCL (use when n<50)	0.0109

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00258	SD (KM)	0.00452
Variance (KM)	2.0401E-5	SE of Mean (KM)	6.7881E-4
k hat (KM)	0.327	k star (KM)	0.322
nu hat (KM)	38.6	nu star (KM)	37.97
theta hat (KM)	0.0079	theta star (KM)	0.00803
80% gamma percentile (KM)	0.00403	90% gamma percentile (KM)	0.00755
95% gamma percentile (KM)	0.0116	99% gamma percentile (KM)	0.0219

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (37.97, α)	24.86	Adjusted Chi Square Value (37.97, β)	24.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.00395	95% Gamma Adjusted KM-UCL (use when n<50)	0.00399

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.903	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.225	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00266	Mean in Log Scale	-6.899
SD in Original Scale	0.00459	SD in Log Scale	1.4
95% t UCL (assumes normality of ROS data)	0.00366	95% Percentile Bootstrap UCL	0.00372
95% BCA Bootstrap UCL	0.00394	95% Bootstrap t UCL	0.00414
95% H-UCL (Log ROS)	0.0047		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.813	KM Geo Mean	0.0011
KM SD (logged)	1.181	95% Critical H Value (KM-Log)	2.669
KM Standard Error of Mean (logged)	0.288	95% H-UCL (KM -Log)	0.00334
KM SD (logged)	1.181	95% Critical H Value (KM-Log)	2.669
KM Standard Error of Mean (logged)	0.288		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00454	Mean in Log Scale	-5.743
SD in Original Scale	0.00413	SD in Log Scale	0.945
95% t UCL (Assumes normality)	0.00544	95% H-Stat UCL	0.00664

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use
95% KM (t) UCL 0.00372

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/L)

General Statistics

Total Number of Observations	40	Number of Distinct Observations	37
		Number of Missing Observations	0
Minimum	0.00977	Mean	0.195
Maximum	1.19	Median	0.14
SD	0.213	Std. Error of Mean	0.0336
Coefficient of Variation	1.093	Skewness	3.111

Normal GOF Test

Shapiro Wilk Test Statistic	0.68	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.94	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.139	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.251	95% Adjusted-CLT UCL (Chen-1995)	0.268
		95% Modified-t UCL (Johnson-1978)	0.254

Gamma GOF Test

A-D Test Statistic	0.675	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.768	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.14	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.142	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.412	k star (bias corrected MLE)	1.323
Theta hat (MLE)	0.138	Theta star (bias corrected MLE)	0.147
nu hat (MLE)	113	nu star (bias corrected)	105.9
MLE Mean (bias corrected)	0.195	MLE Sd (bias corrected)	0.169
		Approximate Chi Square Value (0.05)	83.11
Adjusted Level of Significance	0.044	Adjusted Chi Square Value	82.36

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	0.248	95% Adjusted Gamma UCL (use when n<50)	0.25

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.987	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.94	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.089	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.139	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.628	Mean of logged Data	-2.03
Maximum of Logged Data	0.174	SD of logged Data	0.903

Assuming Lognormal Distribution

95% H-UCL	0.275	90% Chebyshev (MVUE) UCL	0.29
95% Chebyshev (MVUE) UCL	0.333	97.5% Chebyshev (MVUE) UCL	0.393
99% Chebyshev (MVUE) UCL	0.51		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.25	95% Jackknife UCL	0.251
95% Standard Bootstrap UCL	0.249	95% Bootstrap-t UCL	0.283
95% Hall's Bootstrap UCL	0.478	95% Percentile Bootstrap UCL	0.254
95% BCA Bootstrap UCL	0.268		
90% Chebyshev(Mean, Sd) UCL	0.296	95% Chebyshev(Mean, Sd) UCL	0.341
97.5% Chebyshev(Mean, Sd) UCL	0.405	99% Chebyshev(Mean, Sd) UCL	0.529

Suggested UCL to Use

95% Adjusted Gamma UCL 0.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (mg/L)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	4
Number of Detects	1	Number of Non-Detects	15
Number of Distinct Detects	1	Number of Distinct Non-Detects	4

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Molybdenum (mg/L) was not processed!

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nickel (mg/L)

General Statistics

Total Number of Observations	36	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	20
Number of Distinct Detects	15	Number of Distinct Non-Detects	3
Minimum Detect	0.0017	Minimum Non-Detect	0.01
Maximum Detect	0.027	Maximum Non-Detect	0.04
Variance Detects	5.4921E-5	Percent Non-Detects	55.56%
Mean Detects	0.0104	SD Detects	0.00741
Median Detects	0.00828	CV Detects	0.712
Skewness Detects	0.852	Kurtosis Detects	-0.0341
Mean of Logged Detects	-4.83	SD of Logged Detects	0.789

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.899	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00744	KM Standard Error of Mean	0.00115
KM SD	0.00602	95% KM (BCA) UCL	0.00941
95% KM (t) UCL	0.00939	95% KM (Percentile Bootstrap) UCL	0.00932
95% KM (z) UCL	0.00933	95% KM Bootstrap t UCL	0.00985
90% KM Chebyshev UCL	0.0109	95% KM Chebyshev UCL	0.0125
97.5% KM Chebyshev UCL	0.0146	99% KM Chebyshev UCL	0.0189

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.398	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.158	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.218	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.035	k star (bias corrected MLE)	1.695
Theta hat (MLE)	0.00512	Theta star (bias corrected MLE)	0.00614
nu hat (MLE)	65.11	nu star (bias corrected)	54.24
Mean (detects)	0.0104		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	0.0017	Mean	0.0102
Maximum	0.027	Median	0.01
SD	0.00487	CV	0.475
k hat (MLE)	4.373	k star (bias corrected MLE)	4.027
Theta hat (MLE)	0.00234	Theta star (bias corrected MLE)	0.00254
nu hat (MLE)	314.9	nu star (bias corrected)	290
Adjusted Level of Significance (β)	0.0428		
Approximate Chi Square Value (289.95, α)	251.5	Adjusted Chi Square Value (289.95, β)	249.9
95% Gamma Approximate UCL (use when n>=50)	0.0118	95% Gamma Adjusted UCL (use when n<50)	0.0119

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00744	SD (KM)	0.00602
Variance (KM)	3.6231E-5	SE of Mean (KM)	0.00115
k hat (KM)	1.527	k star (KM)	1.418
nu hat (KM)	110	nu star (KM)	102.1
theta hat (KM)	0.00487	theta star (KM)	0.00524
80% gamma percentile (KM)	0.0116	90% gamma percentile (KM)	0.0157
95% gamma percentile (KM)	0.0197	99% gamma percentile (KM)	0.0289

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (102.13, α)	79.81	Adjusted Chi Square Value (102.13, β)	78.92
95% Gamma Approximate KM-UCL (use when n>=50)	0.00952	95% Gamma Adjusted KM-UCL (use when n<50)	0.00963

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.163	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00743	Mean in Log Scale	-5.15
SD in Original Scale	0.00584	SD in Log Scale	0.702
95% t UCL (assumes normality of ROS data)	0.00907	95% Percentile Bootstrap UCL	0.00912
95% BCA Bootstrap UCL	0.00921	95% Bootstrap t UCL	0.0095
95% H-UCL (Log ROS)	0.00949		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.161	KM Geo Mean	0.00574
KM SD (logged)	0.698	95% Critical H Value (KM-Log)	2.073
KM Standard Error of Mean (logged)	0.155	95% H-UCL (KM -Log)	0.00935
KM SD (logged)	0.698	95% Critical H Value (KM-Log)	2.073
KM Standard Error of Mean (logged)	0.155		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00921	Mean in Log Scale	-4.917
SD in Original Scale	0.00672	SD in Log Scale	0.671
95% t UCL (Assumes normality)	0.0111	95% H-Stat UCL	0.0116

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use
95% KM (t) UCL 0.00939

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/L)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	4
Number of Detects	3	Number of Non-Detects	18
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV

The data set for variable Selenium (mg/L) was not processed!

Vanadium (mg/L)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	6
Number of Detects	4	Number of Non-Detects	5
Number of Distinct Detects	4	Number of Distinct Non-Detects	2
Minimum Detect	8.0000E-4	Minimum Non-Detect	0.02
Maximum Detect	0.0051	Maximum Non-Detect	0.05
Variance Detects	4.1292E-6	Percent Non-Detects	55.56%
Mean Detects	0.00383	SD Detects	0.00203
Median Detects	0.0047	CV Detects	0.531
Skewness Detects	-1.912	Kurtosis Detects	3.689
Mean of Logged Detects	-5.783	SD of Logged Detects	0.9

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.737	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.38	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00383	KM Standard Error of Mean	0.00102
KM SD	0.00176	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00571	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0055	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00687	95% KM Chebyshev UCL	0.00825
97.5% KM Chebyshev UCL	0.0102	99% KM Chebyshev UCL	0.0139

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.806	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.66	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.432	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.397	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.461	k star (bias corrected MLE)	0.782
Theta hat (MLE)	0.00155	Theta star (bias corrected MLE)	0.00489
nu hat (MLE)	19.69	nu star (bias corrected)	6.256
Mean (detects)	0.00383		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.0000E-4	Mean	0.00726
Maximum	0.01	Median	0.01
SD	0.00348	CV	0.48
k hat (MLE)	2.622	k star (bias corrected MLE)	1.822
Theta hat (MLE)	0.00277	Theta star (bias corrected MLE)	0.00398
nu hat (MLE)	47.2	nu star (bias corrected)	32.8
Adjusted Level of Significance (β)	0.0231		
Approximate Chi Square Value (32.80, α)	20.71	Adjusted Chi Square Value (32.80, β)	18.71
95% Gamma Approximate UCL (use when n>=50)	0.0115	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00383	SD (KM)	0.00176
Variance (KM)	3.0969E-6	SE of Mean (KM)	0.00102
k hat (KM)	4.724	k star (KM)	3.224
nu hat (KM)	85.04	nu star (KM)	58.03
theta hat (KM)	8.0964E-4	theta star (KM)	0.00119
80% gamma percentile (KM)	0.00541	90% gamma percentile (KM)	0.00668
95% gamma percentile (KM)	0.00786	99% gamma percentile (KM)	0.0104

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (58.03, α)	41.51	Adjusted Chi Square Value (58.03, β)	38.59
95% Gamma Approximate KM-UCL (use when n>=50)	0.00535	95% Gamma Adjusted KM-UCL (use when n<50)	0.00575

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.682	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.413	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0037	Mean in Log Scale	-5.783
SD in Original Scale	0.00204	SD in Log Scale	0.711
95% t UCL (assumes normality of ROS data)	0.00497	95% Percentile Bootstrap UCL	0.00483
95% BCA Bootstrap UCL	0.00475	95% Bootstrap t UCL	0.00504
95% H-UCL (Log ROS)	0.0077		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.783	KM Geo Mean	0.00308
KM SD (logged)	0.78	95% Critical H Value (KM-Log)	2.772
KM Standard Error of Mean (logged)	0.45	95% H-UCL (KM -Log)	0.00896
KM SD (logged)	0.78	95% Critical H Value (KM-Log)	2.772
KM Standard Error of Mean (logged)	0.45		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0139	Mean in Log Scale	-4.721
SD in Original Scale	0.0108	SD in Log Scale	1.184
95% t UCL (Assumes normality)	0.0206	95% H-Stat UCL	0.0831

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.00825

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/L)

General Statistics

Total Number of Observations	81	Number of Distinct Observations	50
Number of Detects	74	Number of Non-Detects	7
Number of Distinct Detects	48	Number of Distinct Non-Detects	4
Minimum Detect	0.0037	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.685	Maximum Non-Detect	0.06
Variance Detects	0.00774	Percent Non-Detects	8.642%
Mean Detects	0.0374	SD Detects	0.088
Median Detects	0.0158	CV Detects	2.353
Skewness Detects	6.039	Kurtosis Detects	41.71
Mean of Logged Detects	-4.018	SD of Logged Detects	0.984

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.365	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.368	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.103	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0346	KM Standard Error of Mean	0.0094
KM SD	0.084	95% KM (BCA) UCL	0.053
95% KM (t) UCL	0.0503	95% KM (Percentile Bootstrap) UCL	0.0512
95% KM (z) UCL	0.0501	95% KM Bootstrap t UCL	0.0726
90% KM Chebyshev UCL	0.0628	95% KM Chebyshev UCL	0.0756
97.5% KM Chebyshev UCL	0.0933	99% KM Chebyshev UCL	0.128

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	6.539	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.79	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.269	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.108	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.81	k star (bias corrected MLE)	0.786
Theta hat (MLE)	0.0462	Theta star (bias corrected MLE)	0.0476
nu hat (MLE)	119.8	nu star (bias corrected)	116.3
Mean (detects)	0.0374		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0037	Mean	0.035
Maximum	0.685	Median	0.014
SD	0.0844	CV	2.41
k hat (MLE)	0.824	k star (bias corrected MLE)	0.802
Theta hat (MLE)	0.0425	Theta star (bias corrected MLE)	0.0437
nu hat (MLE)	133.5	nu star (bias corrected)	129.9
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (129.91, α)	104.6	Adjusted Chi Square Value (129.91, β)	104.2
95% Gamma Approximate UCL (use when n>=50)	0.0435	95% Gamma Adjusted UCL (use when n<50)	0.0437

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0346	SD (KM)	0.084
Variance (KM)	0.00706	SE of Mean (KM)	0.0094
k hat (KM)	0.17	k star (KM)	0.172
nu hat (KM)	27.52	nu star (KM)	27.83
theta hat (KM)	0.204	theta star (KM)	0.202
80% gamma percentile (KM)	0.0417	90% gamma percentile (KM)	0.104
95% gamma percentile (KM)	0.185	99% gamma percentile (KM)	0.414

Appendix D, Table 15. ProUCL Output - Neosho River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (27.83, α)	16.8	Adjusted Chi Square Value (27.83, β)	16.64
95% Gamma Approximate KM-UCL (use when n>=50)	0.0574	95% Gamma Adjusted KM-UCL (use when n<50)	0.0579

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.911	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.6420E-5	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.103	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0346	Mean in Log Scale	-4.157
SD in Original Scale	0.0845	SD in Log Scale	1.069
95% t UCL (assumes normality of ROS data)	0.0502	95% Percentile Bootstrap UCL	0.0513
95% BCA Bootstrap UCL	0.0612	95% Bootstrap t UCL	0.0756
95% H-UCL (Log ROS)	0.0365		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.177	KM Geo Mean	0.0153
KM SD (logged)	1.129	95% Critical H Value (KM-Log)	2.357
KM Standard Error of Mean (logged)	0.131	95% H-UCL (KM -Log)	0.039
KM SD (logged)	1.129	95% Critical H Value (KM-Log)	2.357
KM Standard Error of Mean (logged)	0.131		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0348	Mean in Log Scale	-4.169
SD in Original Scale	0.0845	SD in Log Scale	1.136
95% t UCL (Assumes normality)	0.0504	95% H-Stat UCL	0.0398

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0756

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:51:04 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/L)

General Statistics

Total Number of Observations	161	Number of Distinct Observations	140
Number of Detects	133	Number of Non-Detects	28
Number of Distinct Detects	130	Number of Distinct Non-Detects	10
Minimum Detect	0.0136	Minimum Non-Detect	0.038
Maximum Detect	19.2	Maximum Non-Detect	0.554
Variance Detects	4.876	Percent Non-Detects	17.39%
Mean Detects	0.844	SD Detects	2.208
Median Detects	0.17	CV Detects	2.617
Skewness Detects	5.788	Kurtosis Detects	40.72
Mean of Logged Detects	-1.601	SD of Logged Detects	1.629

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.408	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.353	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0772	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.708	KM Standard Error of Mean	0.16
KM SD	2.021	95% KM (BCA) UCL	0.99
95% KM (t) UCL	0.972	95% KM (Percentile Bootstrap) UCL	1.001
95% KM (z) UCL	0.971	95% KM Bootstrap t UCL	1.146
90% KM Chebyshev UCL	1.187	95% KM Chebyshev UCL	1.405
97.5% KM Chebyshev UCL	1.706	99% KM Chebyshev UCL	2.299

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	6.6	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.831	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.143	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0862	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.451	k star (bias corrected MLE)	0.446
Theta hat (MLE)	1.87	Theta star (bias corrected MLE)	1.892
nu hat (MLE)	120	nu star (bias corrected)	118.6
Mean (detects)	0.844		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.699
Maximum	19.2	Median	0.106
SD	2.03	CV	2.904
k hat (MLE)	0.379	k star (bias corrected MLE)	0.376
Theta hat (MLE)	1.845	Theta star (bias corrected MLE)	1.86
nu hat (MLE)	122	nu star (bias corrected)	121.1
Adjusted Level of Significance (β)	0.0485		
Approximate Chi Square Value (121.06, α)	96.65	Adjusted Chi Square Value (121.06, β)	96.46
95% Gamma Approximate UCL (use when n>=50)	0.876	95% Gamma Adjusted UCL (use when n<50)	0.878

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.708	SD (KM)	2.021
Variance (KM)	4.086	SE of Mean (KM)	0.16
k hat (KM)	0.123	k star (KM)	0.124
nu hat (KM)	39.46	nu star (KM)	40.06
theta hat (KM)	5.774	theta star (KM)	5.688
80% gamma percentile (KM)	0.646	90% gamma percentile (KM)	2.024
95% gamma percentile (KM)	4.019	99% gamma percentile (KM)	10.05

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (40.06, α)	26.56	Adjusted Chi Square Value (40.06, β)	26.46
95% Gamma Approximate KM-UCL (use when n>=50)	1.067	95% Gamma Adjusted KM-UCL (use when n<50)	1.071

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.945	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	4.2587E-5	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.122	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0772	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.709	Mean in Log Scale	-1.833
SD in Original Scale	2.027	SD in Log Scale	1.595
95% t UCL (assumes normality of ROS data)	0.973	95% Percentile Bootstrap UCL	1.005
95% BCA Bootstrap UCL	1.087	95% Bootstrap t UCL	1.135
95% H-UCL (Log ROS)	0.807		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.854	KM Geo Mean	0.157
KM SD (logged)	1.6	95% Critical H Value (KM-Log)	2.743
KM Standard Error of Mean (logged)	0.129	95% H-UCL (KM -Log)	0.797
KM SD (logged)	1.6	95% Critical H Value (KM-Log)	2.743
KM Standard Error of Mean (logged)	0.129		

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.713	Mean in Log Scale	-1.774
SD in Original Scale	2.026	SD in Log Scale	1.551
95% t UCL (Assumes normality)	0.977	95% H-Stat UCL	0.785

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 1.405

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/L)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	22
Number of Detects	27	Number of Non-Detects	38
Number of Distinct Detects	20	Number of Distinct Non-Detects	4
Minimum Detect	9.0000E-4	Minimum Non-Detect	0.002
Maximum Detect	0.0116	Maximum Non-Detect	0.01
Variance Detects	6.7579E-6	Percent Non-Detects	58.46%
Mean Detects	0.00354	SD Detects	0.0026
Median Detects	0.0026	CV Detects	0.734
Skewness Detects	1.253	Kurtosis Detects	1.911
Mean of Logged Detects	-5.906	SD of Logged Detects	0.756

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.864	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.923	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.182	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.167	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00296	KM Standard Error of Mean	3.6926E-4
KM SD	0.00223	95% KM (BCA) UCL	0.00355
95% KM (t) UCL	0.00357	95% KM (Percentile Bootstrap) UCL	0.00359
95% KM (z) UCL	0.00357	95% KM Bootstrap t UCL	0.00364
90% KM Chebyshev UCL	0.00407	95% KM Chebyshev UCL	0.00457
97.5% KM Chebyshev UCL	0.00526	99% KM Chebyshev UCL	0.00663

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.672	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.756	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.116	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.17	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.055	k star (bias corrected MLE)	1.852
Theta hat (MLE)	0.00172	Theta star (bias corrected MLE)	0.00191
nu hat (MLE)	111	nu star (bias corrected)	99.98
Mean (detects)	0.00354		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	9.0000E-4	Mean	0.00732
Maximum	0.0116	Median	0.01
SD	0.00361	CV	0.493
k hat (MLE)	2.347	k star (bias corrected MLE)	2.249
Theta hat (MLE)	0.00312	Theta star (bias corrected MLE)	0.00325
nu hat (MLE)	305.1	nu star (bias corrected)	292.3
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (292.31, α)	253.7	Adjusted Chi Square Value (292.31, β)	252.9
95% Gamma Approximate UCL (use when n>=50)	0.00843	95% Gamma Adjusted UCL (use when n<50)	0.00846

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00296	SD (KM)	0.00223
Variance (KM)	4.9528E-6	SE of Mean (KM)	3.6926E-4
k hat (KM)	1.767	k star (KM)	1.695
nu hat (KM)	229.7	nu star (KM)	220.4
theta hat (KM)	0.00167	theta star (KM)	0.00174
80% gamma percentile (KM)	0.00451	90% gamma percentile (KM)	0.00598
95% gamma percentile (KM)	0.0074	99% gamma percentile (KM)	0.0106

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (220.41, α)	187	Adjusted Chi Square Value (220.41, β)	186.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.00349	95% Gamma Adjusted KM-UCL (use when n<50)	0.0035

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.923	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.126	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.167	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00292	Mean in Log Scale	-6.074
SD in Original Scale	0.00216	SD in Log Scale	0.692
95% t UCL (assumes normality of ROS data)	0.00337	95% Percentile Bootstrap UCL	0.00338
95% BCA Bootstrap UCL	0.0034	95% Bootstrap t UCL	0.00341
95% H-UCL (Log ROS)	0.00348		

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.085	KM Geo Mean	0.00228
KM SD (logged)	0.718	95% Critical H Value (KM-Log)	2.026
KM Standard Error of Mean (logged)	0.127	95% H-UCL (KM -Log)	0.00354
KM SD (logged)	0.718	95% Critical H Value (KM-Log)	2.026
KM Standard Error of Mean (logged)	0.127		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00397	Mean in Log Scale	-5.702
SD in Original Scale	0.00202	SD in Log Scale	0.653
95% t UCL (Assumes normality)	0.00439	95% H-Stat UCL	0.00486

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.00349	95% GROS Approximate Gamma UCL	0.00843

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/L)

General Statistics

Total Number of Observations	60	Number of Distinct Observations	49
Number of Detects	55	Number of Non-Detects	5
Number of Distinct Detects	47	Number of Distinct Non-Detects	2
Minimum Detect	0.014	Minimum Non-Detect	0.01
Maximum Detect	0.176	Maximum Non-Detect	0.2
Variance Detects	0.00107	Percent Non-Detects	8.333%
Mean Detects	0.0703	SD Detects	0.0328
Median Detects	0.067	CV Detects	0.467
Skewness Detects	0.992	Kurtosis Detects	1.37
Mean of Logged Detects	-2.766	SD of Logged Detects	0.492

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.939	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0.0125	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.119	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0671	KM Standard Error of Mean	0.00455
KM SD	0.0343	95% KM (BCA) UCL	0.0743
95% KM (t) UCL	0.0747	95% KM (Percentile Bootstrap) UCL	0.0747
95% KM (z) UCL	0.0746	95% KM Bootstrap t UCL	0.0753
90% KM Chebyshev UCL	0.0808	95% KM Chebyshev UCL	0.087
97.5% KM Chebyshev UCL	0.0956	99% KM Chebyshev UCL	0.112

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.325	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.106	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.12	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.703	k star (bias corrected MLE)	4.459
Theta hat (MLE)	0.0149	Theta star (bias corrected MLE)	0.0158
nu hat (MLE)	517.4	nu star (bias corrected)	490.5
Mean (detects)	0.0703		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0672
Maximum	0.176	Median	0.066
SD	0.0339	CV	0.504
k hat (MLE)	3.641	k star (bias corrected MLE)	3.47
Theta hat (MLE)	0.0185	Theta star (bias corrected MLE)	0.0194
nu hat (MLE)	437	nu star (bias corrected)	416.4
Adjusted Level of Significance (β)	0.046		
Approximate Chi Square Value (416.45, α)	370.1	Adjusted Chi Square Value (416.45, β)	369.1
95% Gamma Approximate UCL (use when n>=50)	0.0756	95% Gamma Adjusted UCL (use when n<50)	0.0758

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0671	SD (KM)	0.0343
Variance (KM)	0.00118	SE of Mean (KM)	0.00455
k hat (KM)	3.824	k star (KM)	3.644
nu hat (KM)	458.9	nu star (KM)	437.3
theta hat (KM)	0.0176	theta star (KM)	0.0184
80% gamma percentile (KM)	0.0936	90% gamma percentile (KM)	0.114
95% gamma percentile (KM)	0.133	99% gamma percentile (KM)	0.175

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (437.31, α)	389.8	Adjusted Chi Square Value (437.31, β)	388.7
95% Gamma Approximate KM-UCL (use when n>=50)	0.0753	95% Gamma Adjusted KM-UCL (use when n<50)	0.0755

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.976	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.541	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.137	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.119	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0674	Mean in Log Scale	-2.825
SD in Original Scale	0.0334	SD in Log Scale	0.537
95% t UCL (assumes normality of ROS data)	0.0746	95% Percentile Bootstrap UCL	0.0748
95% BCA Bootstrap UCL	0.0748	95% Bootstrap t UCL	0.0754
95% H-UCL (Log ROS)	0.0783		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.861	KM Geo Mean	0.0572
KM SD (logged)	0.625	95% Critical H Value (KM-Log)	1.981
KM Standard Error of Mean (logged)	0.0829	95% H-UCL (KM -Log)	0.0818
KM SD (logged)	0.625	95% Critical H Value (KM-Log)	1.981
KM Standard Error of Mean (logged)	0.0829		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.068	Mean in Log Scale	-2.877
SD in Original Scale	0.035	SD in Log Scale	0.736
95% t UCL (Assumes normality)	0.0755	95% H-Stat UCL	0.0901

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0747

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/L)

General Statistics

Total Number of Observations	134	Number of Distinct Observations	70
Number of Detects	85	Number of Non-Detects	49
Number of Distinct Detects	67	Number of Distinct Non-Detects	4
Minimum Detect	1.0000E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.0323	Maximum Non-Detect	0.005
Variance Detects	1.4812E-5	Percent Non-Detects	36.57%
Mean Detects	0.00208	SD Detects	0.00385
Median Detects	0.00128	CV Detects	1.846
Skewness Detects	6.255	Kurtosis Detects	46.3
Mean of Logged Detects	-6.706	SD of Logged Detects	0.929

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.408	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.341	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0962	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00166	KM Standard Error of Mean	2.7471E-4
KM SD	0.00313	95% KM (BCA) UCL	0.00216
95% KM (t) UCL	0.00212	95% KM (Percentile Bootstrap) UCL	0.00213
95% KM (z) UCL	0.00211	95% KM Bootstrap t UCL	0.00255
90% KM Chebyshev UCL	0.00249	95% KM Chebyshev UCL	0.00286
97.5% KM Chebyshev UCL	0.00338	99% KM Chebyshev UCL	0.0044

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.113	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.781	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.191	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0997	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.074	k star (bias corrected MLE)	1.044
Theta hat (MLE)	0.00194	Theta star (bias corrected MLE)	0.002
nu hat (MLE)	182.5	nu star (bias corrected)	177.4
Mean (detects)	0.00208		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.0000E-4	Mean	0.00498
Maximum	0.0323	Median	0.00203
SD	0.0049	CV	0.984
k hat (MLE)	0.918	k star (bias corrected MLE)	0.902
Theta hat (MLE)	0.00543	Theta star (bias corrected MLE)	0.00552
nu hat (MLE)	245.9	nu star (bias corrected)	241.8
Adjusted Level of Significance (β)	0.0482		
Approximate Chi Square Value (241.77, α)	206.8	Adjusted Chi Square Value (241.77, β)	206.4
95% Gamma Approximate UCL (use when n>=50)	0.00582	95% Gamma Adjusted UCL (use when n<50)	0.00583

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00166	SD (KM)	0.00313
Variance (KM)	9.7820E-6	SE of Mean (KM)	2.7471E-4
k hat (KM)	0.282	k star (KM)	0.281
nu hat (KM)	75.71	nu star (KM)	75.35
theta hat (KM)	0.00588	theta star (KM)	0.00591
80% gamma percentile (KM)	0.00251	90% gamma percentile (KM)	0.00494
95% gamma percentile (KM)	0.00776	99% gamma percentile (KM)	0.0152

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (75.35, α)	56.35	Adjusted Chi Square Value (75.35, β)	56.18
95% Gamma Approximate KM-UCL (use when n>=50)	0.00222	95% Gamma Adjusted KM-UCL (use when n<50)	0.00223

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.965	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.0837	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.106	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0962	Detected Data Not Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00167	Mean in Log Scale	-6.906
SD in Original Scale	0.00315	SD in Log Scale	0.912
95% t UCL (assumes normality of ROS data)	0.00212	95% Percentile Bootstrap UCL	0.00215
95% BCA Bootstrap UCL	0.0024	95% Bootstrap t UCL	0.00255
95% H-UCL (Log ROS)	0.0018		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.91	KM Geo Mean	9.9761E-4
KM SD (logged)	0.913	95% Critical H Value (KM-Log)	2.118
KM Standard Error of Mean (logged)	0.0917	95% H-UCL (KM -Log)	0.00179
KM SD (logged)	0.913	95% Critical H Value (KM-Log)	2.118
KM Standard Error of Mean (logged)	0.0917		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00197	Mean in Log Scale	-6.668
SD in Original Scale	0.00312	SD in Log Scale	0.897
95% t UCL (Assumes normality)	0.00242	95% H-Stat UCL	0.00224

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.0017

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/L)

General Statistics

Total Number of Observations	93	Number of Distinct Observations	34
Number of Detects	30	Number of Non-Detects	63
Number of Distinct Detects	30	Number of Distinct Non-Detects	5

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	5.0000E-4	Minimum Non-Detect	0.001
Maximum Detect	0.018	Maximum Non-Detect	0.1
Variance Detects	1.7610E-5	Percent Non-Detects	67.74%
Mean Detects	0.00413	SD Detects	0.0042
Median Detects	0.00213	CV Detects	1.016
Skewness Detects	1.857	Kurtosis Detects	3.321
Mean of Logged Detects	-5.901	SD of Logged Detects	0.907

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.764	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.21	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00287	KM Standard Error of Mean	4.1515E-4
KM SD	0.0031	95% KM (BCA) UCL	0.00359
95% KM (t) UCL	0.00356	95% KM (Percentile Bootstrap) UCL	0.00357
95% KM (z) UCL	0.00355	95% KM Bootstrap t UCL	0.00371
90% KM Chebyshev UCL	0.00411	95% KM Chebyshev UCL	0.00468
97.5% KM Chebyshev UCL	0.00546	99% KM Chebyshev UCL	0.007

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.954	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.767	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.163	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.356	k star (bias corrected MLE)	1.242
Theta hat (MLE)	0.00305	Theta star (bias corrected MLE)	0.00333
nu hat (MLE)	81.35	nu star (bias corrected)	74.55
Mean (detects)	0.00413		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.0000E-4	Mean	0.00811
Maximum	0.018	Median	0.01
SD	0.00363	CV	0.447
k hat (MLE)	2.555	k star (bias corrected MLE)	2.48
Theta hat (MLE)	0.00317	Theta star (bias corrected MLE)	0.00327
nu hat (MLE)	475.3	nu star (bias corrected)	461.3
Adjusted Level of Significance (β)	0.0474		
Approximate Chi Square Value (461.32, α)	412.5	Adjusted Chi Square Value (461.32, β)	411.8
95% Gamma Approximate UCL (use when n>=50)	0.00907	95% Gamma Adjusted UCL (use when n<50)	0.00908

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00287	SD (KM)	0.0031
Variance (KM)	9.6008E-6	SE of Mean (KM)	4.1515E-4
k hat (KM)	0.856	k star (KM)	0.835
nu hat (KM)	159.2	nu star (KM)	155.4
theta hat (KM)	0.00335	theta star (KM)	0.00343
80% gamma percentile (KM)	0.00467	90% gamma percentile (KM)	0.0069
95% gamma percentile (KM)	0.00916	99% gamma percentile (KM)	0.0145

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (155.37, α)	127.6	Adjusted Chi Square Value (155.37, β)	127.2
95% Gamma Approximate KM-UCL (use when n>=50)	0.00349	95% Gamma Adjusted KM-UCL (use when n<50)	0.0035

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.927	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.127	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.159	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00279	Mean in Log Scale	-6.245
SD in Original Scale	0.00288	SD in Log Scale	0.833
95% t UCL (assumes normality of ROS data)	0.00329	95% Percentile Bootstrap UCL	0.0033
95% BCA Bootstrap UCL	0.00339	95% Bootstrap t UCL	0.00341
95% H-UCL (Log ROS)	0.00329		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.231	KM Geo Mean	0.00197
KM SD (logged)	0.817	95% Critical H Value (KM-Log)	2.08
KM Standard Error of Mean (logged)	0.132	95% H-UCL (KM -Log)	0.00328
KM SD (logged)	0.817	95% Critical H Value (KM-Log)	2.08
KM Standard Error of Mean (logged)	0.132		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00955	Mean in Log Scale	-5.296
SD in Original Scale	0.0111	SD in Log Scale	1.165
95% t UCL (Assumes normality)	0.0115	95% H-Stat UCL	0.0132

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.00328

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Cobalt (mg/L)

General Statistics

Total Number of Observations	86	Number of Distinct Observations	38
Number of Detects	36	Number of Non-Detects	50
Number of Distinct Detects	34	Number of Distinct Non-Detects	4
Minimum Detect	3.5200E-4	Minimum Non-Detect	0.005
Maximum Detect	0.00993	Maximum Non-Detect	0.1
Variance Detects	2.8255E-6	Percent Non-Detects	58.14%
Mean Detects	0.00259	SD Detects	0.00168
Median Detects	0.00218	CV Detects	0.65
Skewness Detects	2.745	Kurtosis Detects	10.13
Mean of Logged Detects	-6.111	SD of Logged Detects	0.561

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.749	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.935	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.194	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.145	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00247	KM Standard Error of Mean	2.2324E-4
KM SD	0.00148	95% KM (BCA) UCL	0.00285
95% KM (t) UCL	0.00284	95% KM (Percentile Bootstrap) UCL	0.00285
95% KM (z) UCL	0.00284	95% KM Bootstrap t UCL	0.00296
90% KM Chebyshev UCL	0.00314	95% KM Chebyshev UCL	0.00344
97.5% KM Chebyshev UCL	0.00386	99% KM Chebyshev UCL	0.00469

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.815	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.125	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.148	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.431	k star (bias corrected MLE)	3.163
Theta hat (MLE)	7.5356E-4	Theta star (bias corrected MLE)	8.1725E-4
nu hat (MLE)	247	nu star (bias corrected)	227.8
Mean (detects)	0.00259		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	3.5200E-4	Mean	0.0069
Maximum	0.01	Median	0.01
SD	0.00383	CV	0.556
k hat (MLE)	2.085	k star (bias corrected MLE)	2.02
Theta hat (MLE)	0.00331	Theta star (bias corrected MLE)	0.00341
nu hat (MLE)	358.6	nu star (bias corrected)	347.4
Adjusted Level of Significance (β)	0.0472		
Approximate Chi Square Value (347.43, α)	305.2	Adjusted Chi Square Value (347.43, β)	304.6
95% Gamma Approximate UCL (use when n>=50)	0.00785	95% Gamma Adjusted UCL (use when n<50)	0.00787

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00247	SD (KM)	0.00148
Variance (KM)	2.1813E-6	SE of Mean (KM)	2.2324E-4
k hat (KM)	2.798	k star (KM)	2.708
nu hat (KM)	481.2	nu star (KM)	465.8
theta hat (KM)	8.8296E-4	theta star (KM)	9.1226E-4
80% gamma percentile (KM)	0.00357	90% gamma percentile (KM)	0.00448
95% gamma percentile (KM)	0.00534	99% gamma percentile (KM)	0.00721

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (465.78, α)	416.7	Adjusted Chi Square Value (465.78, β)	416
95% Gamma Approximate KM-UCL (use when n>=50)	0.00276	95% Gamma Adjusted KM-UCL (use when n<50)	0.00277

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.935	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.145	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00244	Mean in Log Scale	-6.137
SD in Original Scale	0.00136	SD in Log Scale	0.498
95% t UCL (assumes normality of ROS data)	0.00269	95% Percentile Bootstrap UCL	0.0027
95% BCA Bootstrap UCL	0.00273	95% Bootstrap t UCL	0.00273
95% H-UCL (Log ROS)	0.0027		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.139	KM Geo Mean	0.00216
KM SD (logged)	0.528	95% Critical H Value (KM-Log)	1.862
KM Standard Error of Mean (logged)	0.0859	95% H-UCL (KM -Log)	0.00276
KM SD (logged)	0.528	95% Critical H Value (KM-Log)	1.862
KM Standard Error of Mean (logged)	0.0859		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0111	Mean in Log Scale	-5.147
SD in Original Scale	0.0118	SD in Log Scale	1.195
95% t UCL (Assumes normality)	0.0133	95% H-Stat UCL	0.0163

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.00276	95% GROS Approximate Gamma UCL	0.00785

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/L)

General Statistics

Total Number of Observations	157	Number of Distinct Observations	91
Number of Detects	101	Number of Non-Detects	56
Number of Distinct Detects	86	Number of Distinct Non-Detects	5
Minimum Detect	0.00143	Minimum Non-Detect	0.005
Maximum Detect	0.049	Maximum Non-Detect	0.1
Variance Detects	3.5401E-5	Percent Non-Detects	35.67%
Mean Detects	0.00472	SD Detects	0.00595
Median Detects	0.00303	CV Detects	1.261
Skewness Detects	5.401	Kurtosis Detects	35.25
Mean of Logged Detects	-5.655	SD of Logged Detects	0.667

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.487	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.29	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0884	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00434	KM Standard Error of Mean	4.6553E-4
KM SD	0.00527	95% KM (BCA) UCL	0.00518
95% KM (t) UCL	0.00511	95% KM (Percentile Bootstrap) UCL	0.00516
95% KM (z) UCL	0.00511	95% KM Bootstrap t UCL	0.00564
90% KM Chebyshev UCL	0.00574	95% KM Chebyshev UCL	0.00637
97.5% KM Chebyshev UCL	0.00725	99% KM Chebyshev UCL	0.00897

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.949	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.767	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.162	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.0905	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	1.823	k star (bias corrected MLE)	1.776
Theta hat (MLE)	0.00259	Theta star (bias corrected MLE)	0.00266
nu hat (MLE)	368.3	nu star (bias corrected)	358.7
Mean (detects)	0.00472		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00143	Mean	0.00663
Maximum	0.049	Median	0.00586
SD	0.00543	CV	0.818
k hat (MLE)	2.058	k star (bias corrected MLE)	2.023
Theta hat (MLE)	0.00322	Theta star (bias corrected MLE)	0.00328
nu hat (MLE)	646.2	nu star (bias corrected)	635.2
Adjusted Level of Significance (β)	0.0485		
Approximate Chi Square Value (635.17, α)	577.7	Adjusted Chi Square Value (635.17, β)	577.2
95% Gamma Approximate UCL (use when n>=50)	0.00729	95% Gamma Adjusted UCL (use when n<50)	0.0073

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00434	SD (KM)	0.00527
Variance (KM)	2.7760E-5	SE of Mean (KM)	4.6553E-4
k hat (KM)	0.679	k star (KM)	0.67
nu hat (KM)	213.1	nu star (KM)	210.4
theta hat (KM)	0.0064	theta star (KM)	0.00648
80% gamma percentile (KM)	0.00714	90% gamma percentile (KM)	0.011
95% gamma percentile (KM)	0.015	99% gamma percentile (KM)	0.0246

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (210.38, α)	177.8	Adjusted Chi Square Value (210.38, β)	177.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.00514	95% Gamma Adjusted KM-UCL (use when n<50)	0.00514

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.9	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	4.8512E-9	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0884	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00428	Mean in Log Scale	-5.699
SD in Original Scale	0.00491	SD in Log Scale	0.612
95% t UCL (assumes normality of ROS data)	0.00493	95% Percentile Bootstrap UCL	0.00494
95% BCA Bootstrap UCL	0.00532	95% Bootstrap t UCL	0.00555
95% H-UCL (Log ROS)	0.00443		

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.708	KM Geo Mean	0.00332
KM SD (logged)	0.626	95% Critical H Value (KM-Log)	1.912
KM Standard Error of Mean (logged)	0.0585	95% H-UCL (KM -Log)	0.00444
KM SD (logged)	0.626	95% Critical H Value (KM-Log)	1.912
KM Standard Error of Mean (logged)	0.0585		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00837	Mean in Log Scale	-5.287
SD in Original Scale	0.00978	SD in Log Scale	0.95
95% t UCL (Assumes normality)	0.00966	95% H-Stat UCL	0.00936

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.00637

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/L)

General Statistics

Total Number of Observations	173	Number of Distinct Observations	160
Number of Detects	168	Number of Non-Detects	5
Number of Distinct Detects	157	Number of Distinct Non-Detects	3
Minimum Detect	0.055	Minimum Non-Detect	0.02
Maximum Detect	14.9	Maximum Non-Detect	0.07
Variance Detects	3.588	Percent Non-Detects	2.89%
Mean Detects	1.287	SD Detects	1.894
Median Detects	0.649	CV Detects	1.471
Skewness Detects	4.027	Kurtosis Detects	21.53
Mean of Logged Detects	-0.452	SD of Logged Detects	1.222

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.61	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0688	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.251	KM Standard Error of Mean	0.143
KM SD	1.873	95% KM (BCA) UCL	1.49
95% KM (t) UCL	1.487	95% KM (Percentile Bootstrap) UCL	1.501
95% KM (z) UCL	1.486	95% KM Bootstrap t UCL	1.552
90% KM Chebyshev UCL	1.679	95% KM Chebyshev UCL	1.873
97.5% KM Chebyshev UCL	2.143	99% KM Chebyshev UCL	2.672

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.998	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.792	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0859	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0745	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.838	k star (bias corrected MLE)	0.827
Theta hat (MLE)	1.537	Theta star (bias corrected MLE)	1.557
nu hat (MLE)	281.4	nu star (bias corrected)	277.7
Mean (detects)	1.287		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.25
Maximum	14.9	Median	0.59
SD	1.879	CV	1.502
k hat (MLE)	0.752	k star (bias corrected MLE)	0.743
Theta hat (MLE)	1.662	Theta star (bias corrected MLE)	1.683
nu hat (MLE)	260.3	nu star (bias corrected)	257.1
Adjusted Level of Significance (β)	0.0486		
Approximate Chi Square Value (257.15, α)	221	Adjusted Chi Square Value (257.15, β)	220.7
95% Gamma Approximate UCL (use when n>=50)	1.455	95% Gamma Adjusted UCL (use when n<50)	1.457

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.251	SD (KM)	1.873
Variance (KM)	3.509	SE of Mean (KM)	0.143
k hat (KM)	0.446	k star (KM)	0.442
nu hat (KM)	154.3	nu star (KM)	153
theta hat (KM)	2.805	theta star (KM)	2.83
80% gamma percentile (KM)	2.039	90% gamma percentile (KM)	3.469
95% gamma percentile (KM)	5.019	99% gamma percentile (KM)	8.879

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (152.96, α)	125.4	Adjusted Chi Square Value (152.96, β)	125.2
95% Gamma Approximate KM-UCL (use when n>=50)	1.526	95% Gamma Adjusted KM-UCL (use when n<50)	1.529

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0143	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0525	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0688	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.251	Mean in Log Scale	-0.538
SD in Original Scale	1.878	SD in Log Scale	1.305
95% t UCL (assumes normality of ROS data)	1.487	95% Percentile Bootstrap UCL	1.497
95% BCA Bootstrap UCL	1.553	95% Bootstrap t UCL	1.554
95% H-UCL (Log ROS)	1.745		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.549	KM Geo Mean	0.578
KM SD (logged)	1.327	95% Critical H Value (KM-Log)	2.469
KM Standard Error of Mean (logged)	0.101	95% H-UCL (KM -Log)	1.789
KM SD (logged)	1.327	95% Critical H Value (KM-Log)	2.469
KM Standard Error of Mean (logged)	0.101		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.251	Mean in Log Scale	-0.554
SD in Original Scale	1.879	SD in Log Scale	1.345
95% t UCL (Assumes normality)	1.487	95% H-Stat UCL	1.834

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	1.789

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/L)

General Statistics

Total Number of Observations	100	Number of Distinct Observations	67
Number of Detects	70	Number of Non-Detects	30
Number of Distinct Detects	63	Number of Distinct Non-Detects	4
Minimum Detect	2.0000E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.101	Maximum Non-Detect	0.01
Variance Detects	3.2801E-4	Percent Non-Detects	30%
Mean Detects	0.0135	SD Detects	0.0181
Median Detects	0.00702	CV Detects	1.344
Skewness Detects	2.892	Kurtosis Detects	9.88
Mean of Logged Detects	-5.041	SD of Logged Detects	1.319

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.675	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.232	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.106	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0101	KM Standard Error of Mean	0.00161
KM SD	0.0159	95% KM (BCA) UCL	0.0128
95% KM (t) UCL	0.0128	95% KM (Percentile Bootstrap) UCL	0.0129
95% KM (z) UCL	0.0128	95% KM Bootstrap t UCL	0.0136
90% KM Chebyshev UCL	0.015	95% KM Chebyshev UCL	0.0172
97.5% KM Chebyshev UCL	0.0202	99% KM Chebyshev UCL	0.0262

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.637	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.79	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0856	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.11	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.808	k star (bias corrected MLE)	0.783
Theta hat (MLE)	0.0167	Theta star (bias corrected MLE)	0.0172
nu hat (MLE)	113.1	nu star (bias corrected)	109.6
Mean (detects)	0.0135		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.0000E-4	Mean	0.0124
Maximum	0.101	Median	0.01
SD	0.0152	CV	1.223
k hat (MLE)	1.094	k star (bias corrected MLE)	1.068
Theta hat (MLE)	0.0114	Theta star (bias corrected MLE)	0.0116
nu hat (MLE)	218.8	nu star (bias corrected)	213.5
Adjusted Level of Significance (β)	0.0476		
Approximate Chi Square Value (213.53, α)	180.7	Adjusted Chi Square Value (213.53, β)	180.3
95% Gamma Approximate UCL (use when n>=50)	0.0147	95% Gamma Adjusted UCL (use when n<50)	0.0147

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0101	SD (KM)	0.0159
Variance (KM)	2.5360E-4	SE of Mean (KM)	0.00161
k hat (KM)	0.406	k star (KM)	0.4
nu hat (KM)	81.17	nu star (KM)	80.07
theta hat (KM)	0.025	theta star (KM)	0.0253
80% gamma percentile (KM)	0.0164	90% gamma percentile (KM)	0.0287
95% gamma percentile (KM)	0.0421	99% gamma percentile (KM)	0.0761

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (80.07, α)	60.45	Adjusted Chi Square Value (80.07, β)	60.2
95% Gamma Approximate KM-UCL (use when n>=50)	0.0134	95% Gamma Adjusted KM-UCL (use when n<50)	0.0135

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.978	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.524	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.106	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0101	Mean in Log Scale	-5.473
SD in Original Scale	0.016	SD in Log Scale	1.391
95% t UCL (assumes normality of ROS data)	0.0128	95% Percentile Bootstrap UCL	0.0128
95% BCA Bootstrap UCL	0.0133	95% Bootstrap t UCL	0.0136
95% H-UCL (Log ROS)	0.0161		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.502	KM Geo Mean	0.00408
KM SD (logged)	1.448	95% Critical H Value (KM-Log)	2.74
KM Standard Error of Mean (logged)	0.161	95% H-UCL (KM -Log)	0.0173
KM SD (logged)	1.448	95% Critical H Value (KM-Log)	2.74
KM Standard Error of Mean (logged)	0.161		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0106	Mean in Log Scale	-5.27
SD in Original Scale	0.0158	SD in Log Scale	1.272
95% t UCL (Assumes normality)	0.0132	95% H-Stat UCL	0.016

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.0134

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/L)

General Statistics

Total Number of Observations	161	Number of Distinct Observations	139
Number of Detects	158	Number of Non-Detects	3
Number of Distinct Detects	138	Number of Distinct Non-Detects	1
Minimum Detect	0.00334	Minimum Non-Detect	0.03
Maximum Detect	1.13	Maximum Non-Detect	0.03
Variance Detects	0.024	Percent Non-Detects	1.863%
Mean Detects	0.177	SD Detects	0.155
Median Detects	0.149	CV Detects	0.874
Skewness Detects	2.554	Kurtosis Detects	10.2
Mean of Logged Detects	-2.102	SD of Logged Detects	0.983

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.797	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.174	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0709	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.174	KM Standard Error of Mean	0.0122
KM SD	0.155	95% KM (BCA) UCL	0.195
95% KM (t) UCL	0.194	95% KM (Percentile Bootstrap) UCL	0.195
95% KM (z) UCL	0.194	95% KM Bootstrap t UCL	0.197
90% KM Chebyshev UCL	0.211	95% KM Chebyshev UCL	0.227
97.5% KM Chebyshev UCL	0.251	99% KM Chebyshev UCL	0.296

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.094	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.771	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0815	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0759	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.49	k star (bias corrected MLE)	1.466
Theta hat (MLE)	0.119	Theta star (bias corrected MLE)	0.121
nu hat (MLE)	470.8	nu star (bias corrected)	463.2
Mean (detects)	0.177		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00334	Mean	0.174
Maximum	1.13	Median	0.143
SD	0.155	CV	0.891
k hat (MLE)	1.399	k star (bias corrected MLE)	1.377
Theta hat (MLE)	0.124	Theta star (bias corrected MLE)	0.126
nu hat (MLE)	450.5	nu star (bias corrected)	443.4
Adjusted Level of Significance (β)	0.0485		
Approximate Chi Square Value (443.40, α)	395.6	Adjusted Chi Square Value (443.40, β)	395.2
95% Gamma Approximate UCL (use when n>=50)	0.195	95% Gamma Adjusted UCL (use when n<50)	0.195

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.174	SD (KM)	0.155
Variance (KM)	0.0239	SE of Mean (KM)	0.0122
k hat (KM)	1.269	k star (KM)	1.25
nu hat (KM)	408.7	nu star (KM)	402.4
theta hat (KM)	0.137	theta star (KM)	0.139
80% gamma percentile (KM)	0.275	90% gamma percentile (KM)	0.38
95% gamma percentile (KM)	0.483	99% gamma percentile (KM)	0.718

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (402.41, α)	356.9	Adjusted Chi Square Value (402.41, β)	356.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.196	95% Gamma Adjusted KM-UCL (use when n<50)	0.197

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.931	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	5.1326E-9	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.105	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0709	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.174	Mean in Log Scale	-2.133
SD in Original Scale	0.155	SD in Log Scale	1
95% t UCL (assumes normality of ROS data)	0.195	95% Percentile Bootstrap UCL	0.195
95% BCA Bootstrap UCL	0.197	95% Bootstrap t UCL	0.198
95% H-UCL (Log ROS)	0.232		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.145	KM Geo Mean	0.117
KM SD (logged)	1.021	95% Critical H Value (KM-Log)	2.178
KM Standard Error of Mean (logged)	0.0811	95% H-UCL (KM -Log)	0.235
KM SD (logged)	1.021	95% Critical H Value (KM-Log)	2.178
KM Standard Error of Mean (logged)	0.0811		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.174	Mean in Log Scale	-2.141
SD in Original Scale	0.155	SD in Log Scale	1.014
95% t UCL (Assumes normality)	0.194	95% H-Stat UCL	0.234

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.227

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/L)

General Statistics

Total Number of Observations	148	Number of Distinct Observations	78
Number of Detects	95	Number of Non-Detects	53
Number of Distinct Detects	75	Number of Distinct Non-Detects	5

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	0.00163	Minimum Non-Detect	0.01
Maximum Detect	0.032	Maximum Non-Detect	0.1
Variance Detects	4.6345E-5	Percent Non-Detects	35.81%
Mean Detects	0.0152	SD Detects	0.00681
Median Detects	0.0151	CV Detects	0.447
Skewness Detects	0.158	Kurtosis Detects	-0.233
Mean of Logged Detects	-4.325	SD of Logged Detects	0.607

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.974	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.259	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0521	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0911	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0134	KM Standard Error of Mean	6.7090E-4
KM SD	0.00708	95% KM (BCA) UCL	0.0145
95% KM (t) UCL	0.0145	95% KM (Percentile Bootstrap) UCL	0.0145
95% KM (z) UCL	0.0145	95% KM Bootstrap t UCL	0.0146
90% KM Chebyshev UCL	0.0154	95% KM Chebyshev UCL	0.0164
97.5% KM Chebyshev UCL	0.0176	99% KM Chebyshev UCL	0.0201

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.505	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.101	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0922	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.733	k star (bias corrected MLE)	3.622
Theta hat (MLE)	0.00408	Theta star (bias corrected MLE)	0.0042
nu hat (MLE)	709.3	nu star (bias corrected)	688.2
Mean (detects)	0.0152		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00163	Mean	0.0141
Maximum	0.032	Median	0.013
SD	0.00606	CV	0.429
k hat (MLE)	4.772	k star (bias corrected MLE)	4.68
Theta hat (MLE)	0.00296	Theta star (bias corrected MLE)	0.00302
nu hat (MLE)	1413	nu star (bias corrected)	1385
Adjusted Level of Significance (β)	0.0484		
Approximate Chi Square Value (N/A, α)	1300	Adjusted Chi Square Value (N/A, β)	1299
95% Gamma Approximate UCL (use when n>=50)	0.0151	95% Gamma Adjusted UCL (use when n<50)	0.0151

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0134	SD (KM)	0.00708
Variance (KM)	5.0134E-5	SE of Mean (KM)	6.7090E-4
k hat (KM)	3.596	k star (KM)	3.527
nu hat (KM)	1064	nu star (KM)	1044
theta hat (KM)	0.00373	theta star (KM)	0.00381
80% gamma percentile (KM)	0.0188	90% gamma percentile (KM)	0.023
95% gamma percentile (KM)	0.0269	99% gamma percentile (KM)	0.0353

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	970.1	Adjusted Chi Square Value (N/A, β)	969.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.0145	95% Gamma Adjusted KM-UCL (use when n<50)	0.0145

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.866	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	3.976E-12	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.141	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0911	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0133	Mean in Log Scale	-4.482
SD in Original Scale	0.00692	SD in Log Scale	0.612
95% t UCL (assumes normality of ROS data)	0.0142	95% Percentile Bootstrap UCL	0.0142
95% BCA Bootstrap UCL	0.0143	95% Bootstrap t UCL	0.0142
95% H-UCL (Log ROS)	0.015		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.501	KM Geo Mean	0.0111
KM SD (logged)	0.696	95% Critical H Value (KM-Log)	1.956
KM Standard Error of Mean (logged)	0.073	95% H-UCL (KM -Log)	0.0158
KM SD (logged)	0.696	95% Critical H Value (KM-Log)	1.956
KM Standard Error of Mean (logged)	0.073		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0152	Mean in Log Scale	-4.373
SD in Original Scale	0.00862	SD in Log Scale	0.671
95% t UCL (Assumes normality)	0.0164	95% H-Stat UCL	0.0176

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0145

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Selenium (mg/L)

General Statistics

Total Number of Observations	61	Number of Distinct Observations	6
Number of Detects	2	Number of Non-Detects	59
Number of Distinct Detects	2	Number of Distinct Non-Detects	6
Minimum Detect	0.001	Minimum Non-Detect	0.001
Maximum Detect	0.002	Maximum Non-Detect	0.035
Variance Detects	5.0000E-7	Percent Non-Detects	96.72%
Mean Detects	0.0015	SD Detects	7.0711E-4
Median Detects	0.0015	CV Detects	0.471
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-6.561	SD of Logged Detects	0.49

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00108	KM Standard Error of Mean	1.0452E-4
KM SD	2.6647E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00125	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.00125	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00139	95% KM Chebyshev UCL	0.00153
97.5% KM Chebyshev UCL	0.00173	99% KM Chebyshev UCL	0.00212

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	8.653	k star (bias corrected MLE)	N/A
Theta hat (MLE)	1.7334E-4	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	34.61	nu star (bias corrected)	N/A
Mean (detects)	0.0015		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00108	SD (KM)	2.6647E-4
Variance (KM)	7.1006E-8	SE of Mean (KM)	1.0452E-4
k hat (KM)	16.33	k star (KM)	15.54
nu hat (KM)	1993	nu star (KM)	1896
theta hat (KM)	6.5934E-5	theta star (KM)	6.9296E-5
80% gamma percentile (KM)	0.0013	90% gamma percentile (KM)	0.00144
95% gamma percentile (KM)	0.00156	99% gamma percentile (KM)	0.00181

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0461
Approximate Chi Square Value (N/A, α)	1796	Adjusted Chi Square Value (N/A, β)	1794
95% Gamma Approximate KM-UCL (use when n>=50)	0.00114	95% Gamma Adjusted KM-UCL (use when n<50)	0.00114

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.8718E-4	Mean in Log Scale	-7.957
SD in Original Scale	4.2777E-4	SD in Log Scale	0.825
95% t UCL (assumes normality of ROS data)	5.7868E-4	95% Percentile Bootstrap UCL	5.7917E-4
95% BCA Bootstrap UCL	5.7750E-4	95% Bootstrap t UCL	5.9545E-4
95% H-UCL (Log ROS)	6.1591E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.854	KM Geo Mean	0.00105
KM SD (logged)	0.185	95% Critical H Value (KM-Log)	1.706
KM Standard Error of Mean (logged)	0.0724	95% H-UCL (KM -Log)	0.00112
KM SD (logged)	0.185	95% Critical H Value (KM-Log)	1.706
KM Standard Error of Mean (logged)	0.0724		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00588	Mean in Log Scale	-5.663
SD in Original Scale	0.00609	SD in Log Scale	1.075
95% t UCL (Assumes normality)	0.00718	95% H-Stat UCL	0.00849

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.00125	KM H-UCL	0.00112
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silica (as SIO2) (mg/L)

General Statistics

Total Number of Observations	23	Number of Distinct Observations	20
Number of Detects	22	Number of Non-Detects	1
Number of Distinct Detects	20	Number of Distinct Non-Detects	1
Minimum Detect	0.2	Minimum Non-Detect	0.5
Maximum Detect	22.6	Maximum Non-Detect	0.5
Variance Detects	23.51	Percent Non-Detects	4.348%
Mean Detects	11.17	SD Detects	4.849
Median Detects	10.35	CV Detects	0.434
Skewness Detects	-0.289	Kurtosis Detects	1.923
Mean of Logged Detects	2.143	SD of Logged Detects	1.103

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.236	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	10.7	KM Standard Error of Mean	1.098
KM SD	5.145	95% KM (BCA) UCL	12.33
95% KM (t) UCL	12.58	95% KM (Percentile Bootstrap) UCL	12.46
95% KM (z) UCL	12.5	95% KM Bootstrap t UCL	12.5
90% KM Chebyshev UCL	13.99	95% KM Chebyshev UCL	15.48
97.5% KM Chebyshev UCL	17.55	99% KM Chebyshev UCL	21.62

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.92	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.756	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.388	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.188	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.997	k star (bias corrected MLE)	1.755
Theta hat (MLE)	5.595	Theta star (bias corrected MLE)	6.366
nu hat (MLE)	87.87	nu star (bias corrected)	77.22
Mean (detects)	11.17		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.2	Mean	10.91
Maximum	22.6	Median	10.2
SD	4.908	CV	0.45
k hat (MLE)	2.005	k star (bias corrected MLE)	1.773
Theta hat (MLE)	5.438	Theta star (bias corrected MLE)	6.151
nu hat (MLE)	92.25	nu star (bias corrected)	81.55
Adjusted Level of Significance (β)	0.0389		
Approximate Chi Square Value (81.55, α)	61.74	Adjusted Chi Square Value (81.55, β)	60.49
95% Gamma Approximate UCL (use when n>=50)	14.4	95% Gamma Adjusted UCL (use when n<50)	14.7

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	10.7	SD (KM)	5.145
Variance (KM)	26.47	SE of Mean (KM)	1.098
k hat (KM)	4.321	k star (KM)	3.787
nu hat (KM)	198.8	nu star (KM)	174.2
theta hat (KM)	2.475	theta star (KM)	2.825
80% gamma percentile (KM)	14.84	90% gamma percentile (KM)	18.06
95% gamma percentile (KM)	21.04	99% gamma percentile (KM)	27.41

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (174.19, α)	144.7	Adjusted Chi Square Value (174.19, β)	142.7
95% Gamma Approximate KM-UCL (use when n>=50)	12.88	95% Gamma Adjusted KM-UCL (use when n<50)	13.05

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.554	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.429	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	10.76	Mean in Log Scale	2.07
SD in Original Scale	5.139	SD in Log Scale	1.132
95% t UCL (assumes normality of ROS data)	12.6	95% Percentile Bootstrap UCL	12.48
95% BCA Bootstrap UCL	12.42	95% Bootstrap t UCL	12.66
95% H-UCL (Log ROS)	28.91		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.98	KM Geo Mean	7.239
KM SD (logged)	1.303	95% Critical H Value (KM-Log)	2.95
KM Standard Error of Mean (logged)	0.278	95% H-UCL (KM -Log)	38.36
KM SD (logged)	1.303	95% Critical H Value (KM-Log)	2.95
KM Standard Error of Mean (logged)	0.278		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	10.7	Mean in Log Scale	1.989
SD in Original Scale	5.256	SD in Log Scale	1.305
95% t UCL (Assumes normality)	12.58	95% H-Stat UCL	38.96

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 15.48

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/L)

General Statistics

Total Number of Observations	55	Number of Distinct Observations	5
Number of Detects	1	Number of Non-Detects	54
Number of Distinct Detects	1	Number of Distinct Non-Detects	4

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Silver (mg/L) was not processed!

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Thallium (mg/L)

General Statistics

Total Number of Observations	42	Number of Distinct Observations	10
Number of Detects	6	Number of Non-Detects	36
Number of Distinct Detects	6	Number of Distinct Non-Detects	7
Minimum Detect	1.0000E-4	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.0016	Maximum Non-Detect	0.025
Variance Detects	2.9067E-7	Percent Non-Detects	85.71%
Mean Detects	5.6667E-4	SD Detects	5.3914E-4
Median Detects	4.5000E-4	CV Detects	0.951
Skewness Detects	1.814	Kurtosis Detects	3.746
Mean of Logged Detects	-7.835	SD of Logged Detects	0.953

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.811	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.309	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.6667E-4	KM Standard Error of Mean	8.4336E-5
KM SD	3.2791E-4	95% KM (BCA) UCL	4.1000E-4
95% KM (t) UCL	4.0859E-4	95% KM (Percentile Bootstrap) UCL	4.1579E-4
95% KM (z) UCL	4.0539E-4	95% KM Bootstrap t UCL	4.7040E-4
90% KM Chebyshev UCL	5.1967E-4	95% KM Chebyshev UCL	6.3428E-4
97.5% KM Chebyshev UCL	7.9334E-4	99% KM Chebyshev UCL	0.00111

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.242	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.2	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.337	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.538	k star (bias corrected MLE)	0.88
Theta hat (MLE)	3.6845E-4	Theta star (bias corrected MLE)	6.4387E-4
nu hat (MLE)	18.46	nu star (bias corrected)	10.56
Mean (detects)	5.6667E-4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	1.0000E-4	Mean	0.00865
Maximum	0.01	Median	0.01
SD	0.00335	CV	0.387
k hat (MLE)	1.727	k star (bias corrected MLE)	1.62
Theta hat (MLE)	0.00501	Theta star (bias corrected MLE)	0.00534
nu hat (MLE)	145.1	nu star (bias corrected)	136
Adjusted Level of Significance (β)	0.0443		
Approximate Chi Square Value (136.04, α)	110.1	Adjusted Chi Square Value (136.04, β)	109.3
95% Gamma Approximate UCL (use when n>=50)	0.0107	95% Gamma Adjusted UCL (use when n<50)	0.0108

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.6667E-4	SD (KM)	3.2791E-4
Variance (KM)	1.0753E-7	SE of Mean (KM)	8.4336E-5
k hat (KM)	0.661	k star (KM)	0.63
nu hat (KM)	55.55	nu star (KM)	52.92
theta hat (KM)	4.0322E-4	theta star (KM)	4.2330E-4
80% gamma percentile (KM)	4.3940E-4	90% gamma percentile (KM)	6.8594E-4
95% gamma percentile (KM)	9.4284E-4	99% gamma percentile (KM)	0.00156

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (52.92, α)	37.21	Adjusted Chi Square Value (52.92, β)	36.74
95% Gamma Approximate KM-UCL (use when n>=50)	3.7927E-4	95% Gamma Adjusted KM-UCL (use when n<50)	3.8412E-4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.171	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.0425E-4	Mean in Log Scale	-9.073
SD in Original Scale	2.7593E-4	SD in Log Scale	1.075
95% t UCL (assumes normality of ROS data)	2.7590E-4	95% Percentile Bootstrap UCL	2.7944E-4
95% BCA Bootstrap UCL	3.1061E-4	95% Bootstrap t UCL	3.2909E-4
95% H-UCL (Log ROS)	3.0793E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-8.63	KM Geo Mean	1.7859E-4
KM SD (logged)	0.789	95% Critical H Value (KM-Log)	2.14
KM Standard Error of Mean (logged)	0.25	95% H-UCL (KM -Log)	3.1736E-4
KM SD (logged)	0.789	95% Critical H Value (KM-Log)	2.14
KM Standard Error of Mean (logged)	0.25		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00373	Mean in Log Scale	-6.952
SD in Original Scale	0.00531	SD in Log Scale	1.78
95% t UCL (Assumes normality)	0.00511	95% H-Stat UCL	0.0118

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use
95% KM (t) UCL 4.0859E-4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/L)

General Statistics

Total Number of Observations	42	Number of Distinct Observations	10
Number of Detects	7	Number of Non-Detects	35
Number of Distinct Detects	7	Number of Distinct Non-Detects	3
Minimum Detect	7.7000E-4	Minimum Non-Detect	0.02
Maximum Detect	0.01	Maximum Non-Detect	0.05
Variance Detects	1.2946E-5	Percent Non-Detects	83.33%
Mean Detects	0.0051	SD Detects	0.0036
Median Detects	0.0048	CV Detects	0.706
Skewness Detects	0.0873	Kurtosis Detects	-1.218
Mean of Logged Detects	-5.645	SD of Logged Detects	1.072

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.919	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.169	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0051	KM Standard Error of Mean	0.00136
KM SD	0.00333	95% KM (BCA) UCL	0.0074
95% KM (t) UCL	0.00738	95% KM (Percentile Bootstrap) UCL	0.00733
95% KM (z) UCL	0.00733	95% KM Bootstrap t UCL	0.008
90% KM Chebyshev UCL	0.00918	95% KM Chebyshev UCL	0.011
97.5% KM Chebyshev UCL	0.0136	99% KM Chebyshev UCL	0.0186

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.518	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.254	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.317	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.513	k star (bias corrected MLE)	0.96
Theta hat (MLE)	0.00337	Theta star (bias corrected MLE)	0.00531
nu hat (MLE)	21.18	nu star (bias corrected)	13.44
Mean (detects)	0.0051		

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.7000E-4	Mean	0.00943
Maximum	0.0151	Median	0.01
SD	0.00255	CV	0.271
k hat (MLE)	5.529	k star (bias corrected MLE)	5.15
Theta hat (MLE)	0.00171	Theta star (bias corrected MLE)	0.00183
nu hat (MLE)	464.4	nu star (bias corrected)	432.6
Adjusted Level of Significance (β)	0.0443		
Approximate Chi Square Value (432.58, α)	385.4	Adjusted Chi Square Value (432.58, β)	383.8
95% Gamma Approximate UCL (use when n>=50)	0.0106	95% Gamma Adjusted UCL (use when n<50)	0.0106

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0051	SD (KM)	0.00333
Variance (KM)	1.1097E-5	SE of Mean (KM)	0.00136
k hat (KM)	2.34	k star (KM)	2.189
nu hat (KM)	196.6	nu star (KM)	183.8
theta hat (KM)	0.00218	theta star (KM)	0.00233
80% gamma percentile (KM)	0.00755	90% gamma percentile (KM)	0.0097
95% gamma percentile (KM)	0.0118	99% gamma percentile (KM)	0.0163

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (183.85, α)	153.5	Adjusted Chi Square Value (183.85, β)	152.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.0061	95% Gamma Adjusted KM-UCL (use when n<50)	0.00614

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.817	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.295	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00563	Mean in Log Scale	-5.645
SD in Original Scale	0.00563	SD in Log Scale	1.023
95% t UCL (assumes normality of ROS data)	0.00709	95% Percentile Bootstrap UCL	0.00715
95% BCA Bootstrap UCL	0.00728	95% Bootstrap t UCL	0.00759
95% H-UCL (Log ROS)	0.00873		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.645	KM Geo Mean	0.00354
KM SD (logged)	0.992	95% Critical H Value (KM-Log)	2.348
KM Standard Error of Mean (logged)	0.405	95% H-UCL (KM -Log)	0.00832
KM SD (logged)	0.992	95% Critical H Value (KM-Log)	2.348
KM Standard Error of Mean (logged)	0.405		

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0143	Mean in Log Scale	-4.42
SD in Original Scale	0.00652	SD in Log Scale	0.747
95% t UCL (Assumes normality)	0.016	95% H-Stat UCL	0.0203

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0073

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/L)

General Statistics

Total Number of Observations	314	Number of Distinct Observations	249
Number of Detects	311	Number of Non-Detects	3
Number of Distinct Detects	249	Number of Distinct Non-Detects	1
Minimum Detect	0.021	Minimum Non-Detect	0.05
Maximum Detect	3.67	Maximum Non-Detect	0.05
Variance Detects	0.266	Percent Non-Detects	0.955%
Mean Detects	0.541	SD Detects	0.516
Median Detects	0.419	CV Detects	0.954
Skewness Detects	1.987	Kurtosis Detects	5.738
Mean of Logged Detects	-1.067	SD of Logged Detects	1.023

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.817	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.158	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0506	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.536	KM Standard Error of Mean	0.0291
KM SD	0.515	95% KM (BCA) UCL	0.581
95% KM (t) UCL	0.584	95% KM (Percentile Bootstrap) UCL	0.583
95% KM (z) UCL	0.584	95% KM Bootstrap t UCL	0.586
90% KM Chebyshev UCL	0.623	95% KM Chebyshev UCL	0.663
97.5% KM Chebyshev UCL	0.717	99% KM Chebyshev UCL	0.825

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.198	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.778	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0511	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.0526	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.247	k star (bias corrected MLE)	1.237
Theta hat (MLE)	0.434	Theta star (bias corrected MLE)	0.437
nu hat (MLE)	775.5	nu star (bias corrected)	769.4
Mean (detects)	0.541		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.535
Maximum	3.67	Median	0.411
SD	0.516	CV	0.963
k hat (MLE)	1.189	k star (bias corrected MLE)	1.18
Theta hat (MLE)	0.45	Theta star (bias corrected MLE)	0.454
nu hat (MLE)	746.6	nu star (bias corrected)	740.8
Adjusted Level of Significance (β)	0.0492		
Approximate Chi Square Value (740.78, α)	678.6	Adjusted Chi Square Value (740.78, β)	678.4
95% Gamma Approximate UCL (use when n>=50)	0.585	95% Gamma Adjusted UCL (use when n<50)	0.585

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.536	SD (KM)	0.515
Variance (KM)	0.265	SE of Mean (KM)	0.0291
k hat (KM)	1.084	k star (KM)	1.075
nu hat (KM)	680.5	nu star (KM)	675.3
theta hat (KM)	0.494	theta star (KM)	0.498
80% gamma percentile (KM)	0.857	90% gamma percentile (KM)	1.212
95% gamma percentile (KM)	1.564	99% gamma percentile (KM)	2.379

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (675.29, α)	616	Adjusted Chi Square Value (675.29, β)	615.7
95% Gamma Approximate KM-UCL (use when n>=50)	0.587	95% Gamma Adjusted KM-UCL (use when n<50)	0.588

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.963	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.2524E-5	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0785	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0506	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.536	Mean in Log Scale	-1.089
SD in Original Scale	0.515	SD in Log Scale	1.042
95% t UCL (assumes normality of ROS data)	0.584	95% Percentile Bootstrap UCL	0.587
95% BCA Bootstrap UCL	0.589	95% Bootstrap t UCL	0.588
95% H-UCL (Log ROS)	0.658		

Appendix D, Table 16. ProUCL Output - Beaver Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.089	KM Geo Mean	0.336
KM SD (logged)	1.042	95% Critical H Value (KM-Log)	2.153
KM Standard Error of Mean (logged)	0.0589	95% H-UCL (KM -Log)	0.657
KM SD (logged)	1.042	95% Critical H Value (KM-Log)	2.153
KM Standard Error of Mean (logged)	0.0589		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.536	Mean in Log Scale	-1.092
SD in Original Scale	0.516	SD in Log Scale	1.049
95% t UCL (Assumes normality)	0.584	95% H-Stat UCL	0.661

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.587	95% GROS Approximate Gamma UCL	0.585

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:56:17 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/L)

General Statistics

Total Number of Observations	27	Number of Distinct Observations	25
Number of Detects	17	Number of Non-Detects	10
Number of Distinct Detects	17	Number of Distinct Non-Detects	8
Minimum Detect	0.0158	Minimum Non-Detect	0.1
Maximum Detect	0.678	Maximum Non-Detect	0.657
Variance Detects	0.0272	Percent Non-Detects	37.04%
Mean Detects	0.373	SD Detects	0.165
Median Detects	0.349	CV Detects	0.442
Skewness Detects	-0.0451	Kurtosis Detects	0.151
Mean of Logged Detects	-1.173	SD of Logged Detects	0.839

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.124	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.286	KM Standard Error of Mean	0.042
KM SD	0.194	95% KM (BCA) UCL	0.367
95% KM (t) UCL	0.358	95% KM (Percentile Bootstrap) UCL	0.357
95% KM (z) UCL	0.355	95% KM Bootstrap t UCL	0.354
90% KM Chebyshev UCL	0.412	95% KM Chebyshev UCL	0.469
97.5% KM Chebyshev UCL	0.548	99% KM Chebyshev UCL	0.704

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.927	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.22	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.211	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.838	k star (bias corrected MLE)	2.377
Theta hat (MLE)	0.131	Theta star (bias corrected MLE)	0.157
nu hat (MLE)	96.5	nu star (bias corrected)	80.81
Mean (detects)	0.373		

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0158	Mean	0.309
Maximum	0.678	Median	0.26
SD	0.158	CV	0.512
k hat (MLE)	3.037	k star (bias corrected MLE)	2.724
Theta hat (MLE)	0.102	Theta star (bias corrected MLE)	0.113
nu hat (MLE)	164	nu star (bias corrected)	147.1
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (147.11, α)	120.1	Adjusted Chi Square Value (147.11, β)	118.5
95% Gamma Approximate UCL (use when n>=50)	0.378	95% Gamma Adjusted UCL (use when n<50)	0.383

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.286	SD (KM)	0.194
Variance (KM)	0.0376	SE of Mean (KM)	0.042
k hat (KM)	2.177	k star (KM)	1.96
nu hat (KM)	117.6	nu star (KM)	105.8
theta hat (KM)	0.131	theta star (KM)	0.146
80% gamma percentile (KM)	0.429	90% gamma percentile (KM)	0.559
95% gamma percentile (KM)	0.683	99% gamma percentile (KM)	0.958

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (105.85, α)	83.1	Adjusted Chi Square Value (105.85, β)	81.82
95% Gamma Approximate KM-UCL (use when n>=50)	0.364	95% Gamma Adjusted KM-UCL (use when n<50)	0.37

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.658	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.291	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.287	Mean in Log Scale	-1.49
SD in Original Scale	0.175	SD in Log Scale	0.817
95% t UCL (assumes normality of ROS data)	0.344	95% Percentile Bootstrap UCL	0.345
95% BCA Bootstrap UCL	0.347	95% Bootstrap t UCL	0.349
95% H-UCL (Log ROS)	0.454		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.815	KM Geo Mean	0.163
KM SD (logged)	1.379	95% Critical H Value (KM-Log)	3.054
KM Standard Error of Mean (logged)	0.321	95% H-UCL (KM -Log)	0.963
KM SD (logged)	1.379	95% Critical H Value (KM-Log)	3.054
KM Standard Error of Mean (logged)	0.321		

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.298	Mean in Log Scale	-1.477
SD in Original Scale	0.174	SD in Log Scale	0.89
95% t UCL (Assumes normality)	0.355	95% H-Stat UCL	0.514

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.358

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/L)

General Statistics

Total Number of Observations	27	Number of Distinct Observations	7
Number of Detects	6	Number of Non-Detects	21
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	0.0552	Minimum Non-Detect	0.2
Maximum Detect	0.0787	Maximum Non-Detect	0.2
Variance Detects	7.9094E-5	Percent Non-Detects	77.78%
Mean Detects	0.066	SD Detects	0.00889
Median Detects	0.0637	CV Detects	0.135
Skewness Detects	0.509	Kurtosis Detects	-1.089
Mean of Logged Detects	-2.725	SD of Logged Detects	0.133

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.265	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.066	KM Standard Error of Mean	0.00363
KM SD	0.00812	95% KM (BCA) UCL	0.0715
95% KM (t) UCL	0.0722	95% KM (Percentile Bootstrap) UCL	0.0718
95% KM (z) UCL	0.072	95% KM Bootstrap t UCL	0.0802
90% KM Chebyshev UCL	0.0769	95% KM Chebyshev UCL	0.0818
97.5% KM Chebyshev UCL	0.0887	99% KM Chebyshev UCL	0.102

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.329	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.697	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.261	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	67.47	k star (bias corrected MLE)	33.85
Theta hat (MLE)	9.7841E-4	Theta star (bias corrected MLE)	0.00195
nu hat (MLE)	809.7	nu star (bias corrected)	406.2
Mean (detects)	0.066		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0482	Mean	0.0661
Maximum	0.086	Median	0.0645
SD	0.0096	CV	0.145
k hat (MLE)	49.09	k star (bias corrected MLE)	43.66
Theta hat (MLE)	0.00135	Theta star (bias corrected MLE)	0.00151
nu hat (MLE)	2651	nu star (bias corrected)	2358
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (N/A, α)	2246	Adjusted Chi Square Value (N/A, β)	2239
95% Gamma Approximate UCL (use when n>=50)	0.0694	95% Gamma Adjusted UCL (use when n<50)	0.0696

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.066	SD (KM)	0.00812
Variance (KM)	6.5911E-5	SE of Mean (KM)	0.00363
k hat (KM)	66.12	k star (KM)	58.8
nu hat (KM)	3571	nu star (KM)	3175
theta hat (KM)	9.9841E-4	theta star (KM)	0.00112
80% gamma percentile (KM)	0.0731	90% gamma percentile (KM)	0.0773
95% gamma percentile (KM)	0.0808	99% gamma percentile (KM)	0.0877

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	3045	Adjusted Chi Square Value (N/A, β)	3037
95% Gamma Approximate KM-UCL (use when n>=50)	0.0688	95% Gamma Adjusted KM-UCL (use when n<50)	0.069

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.94	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0662	Mean in Log Scale	-2.725
SD in Original Scale	0.00955	SD in Log Scale	0.144
95% t UCL (assumes normality of ROS data)	0.0693	95% Percentile Bootstrap UCL	0.0692
95% BCA Bootstrap UCL	0.0691	95% Bootstrap t UCL	0.0695
95% H-UCL (Log ROS)	0.0695		

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.725	KM Geo Mean	0.0655
KM SD (logged)	0.121	95% Critical H Value (KM-Log)	1.723
KM Standard Error of Mean (logged)	0.0543	95% H-UCL (KM -Log)	0.0688
KM SD (logged)	0.121	95% Critical H Value (KM-Log)	1.723
KM Standard Error of Mean (logged)	0.0543		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0924	Mean in Log Scale	-2.397
SD in Original Scale	0.0149	SD in Log Scale	0.188
95% t UCL (Assumes normality)	0.0973	95% H-Stat UCL	0.0989

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0722

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/L)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	14
Number of Detects	13	Number of Non-Detects	52
Number of Distinct Detects	9	Number of Distinct Non-Detects	5
Minimum Detect	2.7000E-5	Minimum Non-Detect	2.0000E-6
Maximum Detect	4.9000E-5	Maximum Non-Detect	0.005
Variance Detects	3.906E-11	Percent Non-Detects	80%
Mean Detects	3.6692E-5	SD Detects	6.2501E-6
Median Detects	3.5000E-5	CV Detects	N/A
Skewness Detects	0.459	Kurtosis Detects	-0.161
Mean of Logged Detects	-10.23	SD of Logged Detects	0.169

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.145	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.234	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	3.0188E-5	KM Standard Error of Mean	3.7945E-6
KM SD	1.4583E-5	95% KM (BCA) UCL	3.5833E-5
95% KM (t) UCL	3.6521E-5	95% KM (Percentile Bootstrap) UCL	3.6000E-5
95% KM (z) UCL	3.6429E-5	95% KM Bootstrap t UCL	3.6063E-5
90% KM Chebyshev UCL	4.1571E-5	95% KM Chebyshev UCL	4.6727E-5
97.5% KM Chebyshev UCL	5.3884E-5	99% KM Chebyshev UCL	6.7942E-5

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.243	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.733	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.131	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.236	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	37.99	k star (bias corrected MLE)	29.28
Theta hat (MLE)	9.6576E-7	Theta star (bias corrected MLE)	1.2533E-6
nu hat (MLE)	987.8	nu star (bias corrected)	761.2
Mean (detects)	3.6692E-5		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	2.7000E-5	Mean	0.00801
Maximum	0.01	Median	0.01
SD	0.00402	CV	0.502
k hat (MLE)	0.674	k star (bias corrected MLE)	0.653
Theta hat (MLE)	0.0119	Theta star (bias corrected MLE)	0.0123
nu hat (MLE)	87.57	nu star (bias corrected)	84.87
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (84.87, α)	64.63	Adjusted Chi Square Value (84.87, β)	64.23
95% Gamma Approximate UCL (use when n>=50)	0.0105	95% Gamma Adjusted UCL (use when n<50)	0.0106

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	3.0188E-5	SD (KM)	1.4583E-5
Variance (KM)	2.127E-10	SE of Mean (KM)	3.7945E-6
k hat (KM)	4.285	k star (KM)	4.098
nu hat (KM)	557.1	nu star (KM)	532.7
theta hat (KM)	7.0444E-6	theta star (KM)	7.3668E-6
80% gamma percentile (KM)	4.1505E-5	90% gamma percentile (KM)	5.0174E-5
95% gamma percentile (KM)	5.8144E-5	99% gamma percentile (KM)	7.5146E-5

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (532.71, α)	480.2	Adjusted Chi Square Value (532.71, β)	479.1
95% Gamma Approximate KM-UCL (use when n>=50)	3.3490E-5	95% Gamma Adjusted KM-UCL (use when n<50)	3.3568E-5

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.974	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.124	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.4408E-5	Mean in Log Scale	-10.3
SD in Original Scale	7.3520E-6	SD in Log Scale	0.214
95% t UCL (assumes normality of ROS data)	3.5930E-5	95% Percentile Bootstrap UCL	3.5919E-5
95% BCA Bootstrap UCL	3.5935E-5	95% Bootstrap t UCL	3.5965E-5
95% H-UCL (Log ROS)	3.6044E-5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-10.77	KM Geo Mean	2.1038E-5
KM SD (logged)	1.14	95% Critical H Value (KM-Log)	2.255
KM Standard Error of Mean (logged)	0.297	95% H-UCL (KM -Log)	5.5544E-5
KM SD (logged)	1.14	95% Critical H Value (KM-Log)	2.255
KM Standard Error of Mean (logged)	0.297		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00148	Mean in Log Scale	-7.496
SD in Original Scale	0.00107	SD in Log Scale	2.167
95% t UCL (Assumes normality)	0.0017	95% H-Stat UCL	0.0137

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 3.6521E-5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/L)

General Statistics

Total Number of Observations	27	Number of Distinct Observations	4
Number of Detects	1	Number of Non-Detects	26
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Copper (mg/L) was not processed!

Iron (mg/L)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	26
Number of Detects	25	Number of Non-Detects	1
Number of Distinct Detects	25	Number of Distinct Non-Detects	1

Minimum Detect	0.0263	Minimum Non-Detect	0.1
Maximum Detect	0.652	Maximum Non-Detect	0.1
Variance Detects	0.0261	Percent Non-Detects	3.846%
Mean Detects	0.272	SD Detects	0.161
Median Detects	0.25	CV Detects	0.595
Skewness Detects	0.804	Kurtosis Detects	0.41
Mean of Logged Detects	-1.509	SD of Logged Detects	0.724

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0969	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.173	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.264	KM Standard Error of Mean	0.0321
KM SD	0.16	95% KM (BCA) UCL	0.313
95% KM (t) UCL	0.318	95% KM (Percentile Bootstrap) UCL	0.317
95% KM (z) UCL	0.316	95% KM Bootstrap t UCL	0.325
90% KM Chebyshev UCL	0.36	95% KM Chebyshev UCL	0.404
97.5% KM Chebyshev UCL	0.464	99% KM Chebyshev UCL	0.583

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.211	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.118	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.176	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.582	k star (bias corrected MLE)	2.299
Theta hat (MLE)	0.105	Theta star (bias corrected MLE)	0.118
nu hat (MLE)	129.1	nu star (bias corrected)	115
Mean (detects)	0.272		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0263	Mean	0.264
Maximum	0.652	Median	0.238
SD	0.163	CV	0.62
k hat (MLE)	2.383	k star (bias corrected MLE)	2.134
Theta hat (MLE)	0.111	Theta star (bias corrected MLE)	0.124
nu hat (MLE)	123.9	nu star (bias corrected)	110.9
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (110.95, α)	87.64	Adjusted Chi Square Value (110.95, β)	86.27
95% Gamma Approximate UCL (use when n>=50)	0.334	95% Gamma Adjusted UCL (use when n<50)	0.339

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.264	SD (KM)	0.16
Variance (KM)	0.0257	SE of Mean (KM)	0.0321
k hat (KM)	2.705	k star (KM)	2.419
nu hat (KM)	140.7	nu star (KM)	125.8
theta hat (KM)	0.0974	theta star (KM)	0.109
80% gamma percentile (KM)	0.386	90% gamma percentile (KM)	0.491
95% gamma percentile (KM)	0.59	99% gamma percentile (KM)	0.806

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (125.78, α)	100.9	Adjusted Chi Square Value (125.78, β)	99.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.329	95% Gamma Adjusted KM-UCL (use when n<50)	0.334

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.138	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.173	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.264	Mean in Log Scale	-1.554
SD in Original Scale	0.163	SD in Log Scale	0.745
95% t UCL (assumes normality of ROS data)	0.318	95% Percentile Bootstrap UCL	0.316
95% BCA Bootstrap UCL	0.321	95% Bootstrap t UCL	0.324
95% H-UCL (Log ROS)	0.387		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.562	KM Geo Mean	0.21
KM SD (logged)	0.752	95% Critical H Value (KM-Log)	2.209
KM Standard Error of Mean (logged)	0.153	95% H-UCL (KM -Log)	0.388
KM SD (logged)	0.752	95% Critical H Value (KM-Log)	2.209
KM Standard Error of Mean (logged)	0.153		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.263	Mean in Log Scale	-1.567
SD in Original Scale	0.164	SD in Log Scale	0.767
95% t UCL (Assumes normality)	0.318	95% H-Stat UCL	0.394

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.318

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lead (mg/L)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	17
Number of Detects	14	Number of Non-Detects	51
Number of Distinct Detects	12	Number of Distinct Non-Detects	5
Minimum Detect	2.5500E-4	Minimum Non-Detect	4.0000E-4
Maximum Detect	0.012	Maximum Non-Detect	5
Variance Detects	9.7426E-6	Percent Non-Detects	78.46%
Mean Detects	0.00116	SD Detects	0.00312
Median Detects	3.0850E-4	CV Detects	2.693
Skewness Detects	3.737	Kurtosis Detects	13.98
Mean of Logged Detects	-7.798	SD of Logged Detects	0.995

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.317	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.507	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.1119E-4	KM Standard Error of Mean	1.9505E-4
KM SD	0.00147	95% KM (BCA) UCL	8.9320E-4
95% KM (t) UCL	8.3673E-4	95% KM (Percentile Bootstrap) UCL	8.8592E-4
95% KM (z) UCL	8.3202E-4	95% KM Bootstrap t UCL	0.00362
90% KM Chebyshev UCL	0.0011	95% KM Chebyshev UCL	0.00136
97.5% KM Chebyshev UCL	0.00173	99% KM Chebyshev UCL	0.00245

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.009	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.785	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.456	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.24	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.596	k star (bias corrected MLE)	0.516
Theta hat (MLE)	0.00194	Theta star (bias corrected MLE)	0.00225
nu hat (MLE)	16.69	nu star (bias corrected)	14.45
Mean (detects)	0.00116		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	2.5500E-4	Mean	0.0081
Maximum	0.012	Median	0.01
SD	0.00392	CV	0.485
k hat (MLE)	1.189	k star (bias corrected MLE)	1.144
Theta hat (MLE)	0.00681	Theta star (bias corrected MLE)	0.00708
nu hat (MLE)	154.5	nu star (bias corrected)	148.7
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (148.71, α)	121.5	Adjusted Chi Square Value (148.71, β)	121
95% Gamma Approximate UCL (use when n>=50)	0.00991	95% Gamma Adjusted UCL (use when n<50)	0.00995

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.1119E-4	SD (KM)	0.00147
Variance (KM)	2.1698E-6	SE of Mean (KM)	1.9505E-4
k hat (KM)	0.12	k star (KM)	0.125
nu hat (KM)	15.66	nu star (KM)	16.27
theta hat (KM)	0.00424	theta star (KM)	0.00409
80% gamma percentile (KM)	4.6942E-4	90% gamma percentile (KM)	0.00146
95% gamma percentile (KM)	0.0029	99% gamma percentile (KM)	0.00724

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (16.27, α)	8.151	Adjusted Chi Square Value (16.27, β)	8.02
95% Gamma Approximate KM-UCL (use when n>=50)	0.00102	95% Gamma Adjusted KM-UCL (use when n<50)	0.00104

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.483	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.342	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.7551E-4	Mean in Log Scale	-7.911
SD in Original Scale	0.00146	SD in Log Scale	0.678
95% t UCL (assumes normality of ROS data)	8.7675E-4	95% Percentile Bootstrap UCL	9.2871E-4
95% BCA Bootstrap UCL	0.00129	95% Bootstrap t UCL	0.0021
95% H-UCL (Log ROS)	5.4636E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-8.004	KM Geo Mean	3.3409E-4
KM SD (logged)	0.505	95% Critical H Value (KM-Log)	1.868
KM Standard Error of Mean (logged)	0.0843	95% H-UCL (KM -Log)	4.2693E-4
KM SD (logged)	0.505	95% Critical H Value (KM-Log)	1.868
KM Standard Error of Mean (logged)	0.0843		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.118	Mean in Log Scale	-6.056
SD in Original Scale	0.528	SD in Log Scale	1.885
95% t UCL (Assumes normality)	0.227	95% H-Stat UCL	0.0274

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.0013€

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/L)

General Statistics

Total Number of Observations	27	Number of Distinct Observations	22
Number of Detects	21	Number of Non-Detects	6
Number of Distinct Detects	20	Number of Distinct Non-Detects	2
Minimum Detect	0.0112	Minimum Non-Detect	0.005
Maximum Detect	0.332	Maximum Non-Detect	0.015
Variance Detects	0.00897	Percent Non-Detects	22.22%
Mean Detects	0.0796	SD Detects	0.0947
Median Detects	0.0322	CV Detects	1.191
Skewness Detects	1.969	Kurtosis Detects	3.41
Mean of Logged Detects	-3.078	SD of Logged Detects	1.036

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.696	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0636	KM Standard Error of Mean	0.0171
KM SD	0.0869	95% KM (BCA) UCL	0.0941
95% KM (t) UCL	0.0928	95% KM (Percentile Bootstrap) UCL	0.093
95% KM (z) UCL	0.0917	95% KM Bootstrap t UCL	0.111
90% KM Chebyshev UCL	0.115	95% KM Chebyshev UCL	0.138
97.5% KM Chebyshev UCL	0.171	99% KM Chebyshev UCL	0.234

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.135	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.768	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.229	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.195	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.05	k star (bias corrected MLE)	0.932
Theta hat (MLE)	0.0758	Theta star (bias corrected MLE)	0.0854
nu hat (MLE)	44.11	nu star (bias corrected)	39.14
Mean (detects)	0.0796		

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0641
Maximum	0.332	Median	0.0242
SD	0.0881	CV	1.375
k hat (MLE)	0.876	k star (bias corrected MLE)	0.803
Theta hat (MLE)	0.0732	Theta star (bias corrected MLE)	0.0798
nu hat (MLE)	47.29	nu star (bias corrected)	43.37
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (43.37, α)	29.27	Adjusted Chi Square Value (43.37, β)	28.52
95% Gamma Approximate UCL (use when n>=50)	0.095	95% Gamma Adjusted UCL (use when n<50)	0.0975

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0636	SD (KM)	0.0869
Variance (KM)	0.00754	SE of Mean (KM)	0.0171
k hat (KM)	0.536	k star (KM)	0.501
nu hat (KM)	28.92	nu star (KM)	27.04
theta hat (KM)	0.119	theta star (KM)	0.127
80% gamma percentile (KM)	0.104	90% gamma percentile (KM)	0.172
95% gamma percentile (KM)	0.244	99% gamma percentile (KM)	0.421

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (27.04, α)	16.18	Adjusted Chi Square Value (27.04, β)	15.65
95% Gamma Approximate KM-UCL (use when n>=50)	0.106	95% Gamma Adjusted KM-UCL (use when n<50)	0.11

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.18	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.063	Mean in Log Scale	-3.59
SD in Original Scale	0.0889	SD in Log Scale	1.353
95% t UCL (assumes normality of ROS data)	0.0922	95% Percentile Bootstrap UCL	0.0928
95% BCA Bootstrap UCL	0.0984	95% Bootstrap t UCL	0.116
95% H-UCL (Log ROS)	0.153		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.497	KM Geo Mean	0.0303
KM SD (logged)	1.202	95% Critical H Value (KM-Log)	2.795
KM Standard Error of Mean (logged)	0.245	95% H-UCL (KM -Log)	0.121
KM SD (logged)	1.202	95% Critical H Value (KM-Log)	2.795
KM Standard Error of Mean (logged)	0.245		

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0634	Mean in Log Scale	-3.522
SD in Original Scale	0.0886	SD in Log Scale	1.257
95% t UCL (Assumes normality)	0.0925	95% H-Stat UCL	0.132

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics
Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use
KM H-UCL 0.121

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/L)

General Statistics

Total Number of Observations	27	Number of Distinct Observations	3
Number of Detects	1	Number of Non-Detects	26
Number of Distinct Detects	1	Number of Distinct Non-Detects	2

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Nickel (mg/L) was not processed!

Vanadium (mg/L)

General Statistics

Total Number of Observations	27	Number of Distinct Observations	3
Number of Detects	1	Number of Non-Detects	26
Number of Distinct Detects	1	Number of Distinct Non-Detects	2

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Vanadium (mg/L) was not processed!

Zinc (mg/L)

General Statistics

Total Number of Observations	65	Number of Distinct Observations	19
Number of Detects	21	Number of Non-Detects	44
Number of Distinct Detects	16	Number of Distinct Non-Detects	4

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	0.00287	Minimum Non-Detect	0.01
Maximum Detect	0.408	Maximum Non-Detect	0.0603
Variance Detects	0.00754	Percent Non-Detects	67.69%
Mean Detects	0.0345	SD Detects	0.0868
Median Detects	0.0123	CV Detects	2.514
Skewness Detects	4.385	Kurtosis Detects	19.64
Mean of Logged Detects	-4.235	SD of Logged Detects	1.026

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.333	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.426	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0179	KM Standard Error of Mean	0.00635
KM SD	0.0496	95% KM (BCA) UCL	0.0302
95% KM (t) UCL	0.0285	95% KM (Percentile Bootstrap) UCL	0.0298
95% KM (z) UCL	0.0283	95% KM Bootstrap t UCL	0.0671
90% KM Chebyshev UCL	0.0369	95% KM Chebyshev UCL	0.0456
97.5% KM Chebyshev UCL	0.0575	99% KM Chebyshev UCL	0.0811

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.973	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.788	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.358	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.198	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.696	k star (bias corrected MLE)	0.628
Theta hat (MLE)	0.0496	Theta star (bias corrected MLE)	0.055
nu hat (MLE)	29.22	nu star (bias corrected)	26.38
Mean (detects)	0.0345		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00287	Mean	0.0223
Maximum	0.408	Median	0.01
SD	0.0507	CV	2.272
k hat (MLE)	1.168	k star (bias corrected MLE)	1.124
Theta hat (MLE)	0.0191	Theta star (bias corrected MLE)	0.0199
nu hat (MLE)	151.8	nu star (bias corrected)	146.1
Adjusted Level of Significance (β)	0.0463		
Approximate Chi Square Value (146.12, α)	119.2	Adjusted Chi Square Value (146.12, β)	118.6
95% Gamma Approximate UCL (use when n>=50)	0.0274	95% Gamma Adjusted UCL (use when n<50)	0.0275

Appendix D, Table 17. ProUCL Output - Lost Creek Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0179	SD (KM)	0.0496
Variance (KM)	0.00246	SE of Mean (KM)	0.00635
k hat (KM)	0.129	k star (KM)	0.134
nu hat (KM)	16.81	nu star (KM)	17.37
theta hat (KM)	0.138	theta star (KM)	0.134
80% gamma percentile (KM)	0.0175	90% gamma percentile (KM)	0.0519
95% gamma percentile (KM)	0.1	99% gamma percentile (KM)	0.244

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (17.37, α)	8.937	Adjusted Chi Square Value (17.37, β)	8.799
95% Gamma Approximate KM-UCL (use when n>=50)	0.0347	95% Gamma Adjusted KM-UCL (use when n<50)	0.0352

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.234	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0184	Mean in Log Scale	-4.567
SD in Original Scale	0.0501	SD in Log Scale	0.814
95% t UCL (assumes normality of ROS data)	0.0288	95% Percentile Bootstrap UCL	0.0304
95% BCA Bootstrap UCL	0.0386	95% Bootstrap t UCL	0.0742
95% H-UCL (Log ROS)	0.0179		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.567	KM Geo Mean	0.0104
KM SD (logged)	0.737	95% Critical H Value (KM-Log)	2.042
KM Standard Error of Mean (logged)	0.134	95% H-UCL (KM -Log)	0.0164
KM SD (logged)	0.737	95% Critical H Value (KM-Log)	2.042
KM Standard Error of Mean (logged)	0.134		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0237	Mean in Log Scale	-4.175
SD in Original Scale	0.0498	SD in Log Scale	0.743
95% t UCL (Assumes normality)	0.034	95% H-Stat UCL	0.0245

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.0456

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:58:50 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/L)

General Statistics

Total Number of Observations	63	Number of Distinct Observations	59
Number of Detects	49	Number of Non-Detects	14
Number of Distinct Detects	47	Number of Distinct Non-Detects	12
Minimum Detect	0.0784	Minimum Non-Detect	0.225
Maximum Detect	12.8	Maximum Non-Detect	0.923
Variance Detects	5.704	Percent Non-Detects	22.22%
Mean Detects	1.583	SD Detects	2.388
Median Detects	0.914	CV Detects	1.509
Skewness Detects	3.256	Kurtosis Detects	11.83
Mean of Logged Detects	-0.322	SD of Logged Detects	1.324

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.603	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.264	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.126	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.271	KM Standard Error of Mean	0.276
KM SD	2.166	95% KM (BCA) UCL	1.786
95% KM (t) UCL	1.731	95% KM (Percentile Bootstrap) UCL	1.739
95% KM (z) UCL	1.725	95% KM Bootstrap t UCL	2.06
90% KM Chebyshev UCL	2.098	95% KM Chebyshev UCL	2.473
97.5% KM Chebyshev UCL	2.994	99% KM Chebyshev UCL	4.016

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.003	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.792	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.104	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.132	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.764	k star (bias corrected MLE)	0.731
Theta hat (MLE)	2.071	Theta star (bias corrected MLE)	2.166
nu hat (MLE)	74.89	nu star (bias corrected)	71.64
Mean (detects)	1.583		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.234
Maximum	12.8	Median	0.62
SD	2.202	CV	1.786
k hat (MLE)	0.437	k star (bias corrected MLE)	0.427
Theta hat (MLE)	2.821	Theta star (bias corrected MLE)	2.889
nu hat (MLE)	55.09	nu star (bias corrected)	53.8
Adjusted Level of Significance (β)	0.0462		
Approximate Chi Square Value (53.80, α)	37.95	Adjusted Chi Square Value (53.80, β)	37.64
95% Gamma Approximate UCL (use when n>=50)	1.749	95% Gamma Adjusted UCL (use when n<50)	1.763

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.271	SD (KM)	2.166
Variance (KM)	4.692	SE of Mean (KM)	0.276
k hat (KM)	0.344	k star (KM)	0.338
nu hat (KM)	43.36	nu star (KM)	42.63
theta hat (KM)	3.692	theta star (KM)	3.756
80% gamma percentile (KM)	2	90% gamma percentile (KM)	3.688
95% gamma percentile (KM)	5.589	99% gamma percentile (KM)	10.46

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (42.63, α)	28.66	Adjusted Chi Square Value (42.63, β)	28.39
95% Gamma Approximate KM-UCL (use when n>=50)	1.89	95% Gamma Adjusted KM-UCL (use when n<50)	1.908

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.119	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.126	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.273	Mean in Log Scale	-0.628
SD in Original Scale	2.181	SD in Log Scale	1.306
95% t UCL (assumes normality of ROS data)	1.732	95% Percentile Bootstrap UCL	1.784
95% BCA Bootstrap UCL	1.933	95% Bootstrap t UCL	2.023
95% H-UCL (Log ROS)	1.821		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.68	KM Geo Mean	0.506
KM SD (logged)	1.363	95% Critical H Value (KM-Log)	2.311
KM Standard Error of Mean (logged)	0.178	95% H-UCL (KM -Log)	1.913
KM SD (logged)	1.363	95% Critical H Value (KM-Log)	2.311
KM Standard Error of Mean (logged)	0.178		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.291	Mean in Log Scale	-0.559
SD in Original Scale	2.173	SD in Log Scale	1.262
95% t UCL (Assumes normality)	1.748	95% H-Stat UCL	1.815

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL 1.89

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/L)

General Statistics

Total Number of Observations	51	Number of Distinct Observations	5
Number of Detects	1	Number of Non-Detects	50
Number of Distinct Detects	1	Number of Distinct Non-Detects	4

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Antimony (mg/L) was not processed!

Arsenic (mg/L)

General Statistics

Total Number of Observations	61	Number of Distinct Observations	6
Number of Detects	11	Number of Non-Detects	50
Number of Distinct Detects	4	Number of Distinct Non-Detects	2
Minimum Detect	7.0000E-4	Minimum Non-Detect	0.005
Maximum Detect	0.001	Maximum Non-Detect	0.01
Variance Detects	1.4545E-8	Percent Non-Detects	81.97%
Mean Detects	8.6364E-4	SD Detects	1.2060E-4
Median Detects	8.0000E-4	CV Detects	0.14
Skewness Detects	0.0276	Kurtosis Detects	-1.667
Mean of Logged Detects	-7.063	SD of Logged Detects	0.141

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.834	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.247	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data appear Normal at 5% Significance Level	

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	8.6364E-4	KM Standard Error of Mean	3.6364E-5
KM SD	1.1499E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	9.2439E-4	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	9.2345E-4	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	9.7273E-4	95% KM Chebyshev UCL	0.00102
97.5% KM Chebyshev UCL	0.00109	99% KM Chebyshev UCL	0.00123

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.822	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.728	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.244	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	55.92	k star (bias corrected MLE)	40.73
Theta hat (MLE)	1.5444E-5	Theta star (bias corrected MLE)	2.1204E-5
nu hat (MLE)	1230	nu star (bias corrected)	896.1
Mean (detects)	8.6364E-4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	7.0000E-4	Mean	0.00835
Maximum	0.01	Median	0.01
SD	0.00354	CV	0.424
k hat (MLE)	2.05	k star (bias corrected MLE)	1.961
Theta hat (MLE)	0.00407	Theta star (bias corrected MLE)	0.00426
nu hat (MLE)	250.2	nu star (bias corrected)	239.2
Adjusted Level of Significance (β)	0.0461		
Approximate Chi Square Value (239.18, α)	204.4	Adjusted Chi Square Value (239.18, β)	203.6
95% Gamma Approximate UCL (use when n>=50)	0.00977	95% Gamma Adjusted UCL (use when n<50)	0.00981

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	8.6364E-4	SD (KM)	1.1499E-4
Variance (KM)	1.3223E-8	SE of Mean (KM)	3.6364E-5
k hat (KM)	56.41	k star (KM)	53.64
nu hat (KM)	6882	nu star (KM)	6544
theta hat (KM)	1.5311E-5	theta star (KM)	1.6100E-5
80% gamma percentile (KM)	9.6099E-4	90% gamma percentile (KM)	0.00102
95% gamma percentile (KM)	0.00107	99% gamma percentile (KM)	0.00116

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	6357	Adjusted Chi Square Value (N/A, β)	6353
95% Gamma Approximate KM-UCL (use when n>=50)	8.8904E-4	95% Gamma Adjusted KM-UCL (use when n<50)	8.8966E-4

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.841	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.23	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	8.6471E-4	Mean in Log Scale	-7.063
SD in Original Scale	1.2479E-4	SD in Log Scale	0.144
95% t UCL (assumes normality of ROS data)	8.9140E-4	95% Percentile Bootstrap UCL	8.9200E-4
95% BCA Bootstrap UCL	8.9180E-4	95% Bootstrap t UCL	8.9234E-4
95% H-UCL (Log ROS)	8.9255E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.063	KM Geo Mean	8.5593E-4
KM SD (logged)	0.134	95% Critical H Value (KM-Log)	1.689
KM Standard Error of Mean (logged)	0.0425	95% H-UCL (KM -Log)	8.8935E-4
KM SD (logged)	0.134	95% Critical H Value (KM-Log)	1.689
KM Standard Error of Mean (logged)	0.0425		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00421	Mean in Log Scale	-5.628
SD in Original Scale	0.00162	SD in Log Scale	0.687
95% t UCL (Assumes normality)	0.00456	95% H-Stat UCL	0.00543

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 9.2439E-4

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/L)

General Statistics

Total Number of Observations	56	Number of Distinct Observations	31
Number of Detects	31	Number of Non-Detects	25
Number of Distinct Detects	30	Number of Distinct Non-Detects	1

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	0.046	Minimum Non-Detect	0.2
Maximum Detect	0.153	Maximum Non-Detect	0.2
Variance Detects	4.4556E-4	Percent Non-Detects	44.64%
Mean Detects	0.0738	SD Detects	0.0211
Median Detects	0.069	CV Detects	0.286
Skewness Detects	1.958	Kurtosis Detects	5.88
Mean of Logged Detects	-2.64	SD of Logged Detects	0.253

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.834	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.929	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.181	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.156	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0738	KM Standard Error of Mean	0.00379
KM SD	0.0208	95% KM (BCA) UCL	0.0802
95% KM (t) UCL	0.0801	95% KM (Percentile Bootstrap) UCL	0.0804
95% KM (z) UCL	0.08	95% KM Bootstrap t UCL	0.0829
90% KM Chebyshev UCL	0.0852	95% KM Chebyshev UCL	0.0903
97.5% KM Chebyshev UCL	0.0975	99% KM Chebyshev UCL	0.112

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.926	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.745	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.142	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.158	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	15.3	k star (bias corrected MLE)	13.84
Theta hat (MLE)	0.00482	Theta star (bias corrected MLE)	0.00533
nu hat (MLE)	948.6	nu star (bias corrected)	858.2
Mean (detects)	0.0738		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0406	Mean	0.0738
Maximum	0.153	Median	0.0697
SD	0.0201	CV	0.272
k hat (MLE)	15.24	k star (bias corrected MLE)	14.44
Theta hat (MLE)	0.00484	Theta star (bias corrected MLE)	0.00511
nu hat (MLE)	1707	nu star (bias corrected)	1617
Adjusted Level of Significance (β)	0.0457		
Approximate Chi Square Value (N/A, α)	1524	Adjusted Chi Square Value (N/A, β)	1522
95% Gamma Approximate UCL (use when n>=50)	0.0782	95% Gamma Adjusted UCL (use when n<50)	0.0783

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0738	SD (KM)	0.0208
Variance (KM)	4.3119E-4	SE of Mean (KM)	0.00379
k hat (KM)	12.62	k star (KM)	11.96
nu hat (KM)	1414	nu star (KM)	1340
theta hat (KM)	0.00584	theta star (KM)	0.00617
80% gamma percentile (KM)	0.0909	90% gamma percentile (KM)	0.102
95% gamma percentile (KM)	0.112	99% gamma percentile (KM)	0.132

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1256	Adjusted Chi Square Value (N/A, β)	1253
95% Gamma Approximate KM-UCL (use when n>=50)	0.0787	95% Gamma Adjusted KM-UCL (use when n<50)	0.0788

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.929	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.156	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0736	Mean in Log Scale	-2.64
SD in Original Scale	0.0194	SD in Log Scale	0.244
95% t UCL (assumes normality of ROS data)	0.0779	95% Percentile Bootstrap UCL	0.0779
95% BCA Bootstrap UCL	0.0783	95% Bootstrap t UCL	0.0786
95% H-UCL (Log ROS)	0.0778		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.64	KM Geo Mean	0.0714
KM SD (logged)	0.249	95% Critical H Value (KM-Log)	1.717
KM Standard Error of Mean (logged)	0.0454	95% H-UCL (KM -Log)	0.078
KM SD (logged)	0.249	95% Critical H Value (KM-Log)	1.717
KM Standard Error of Mean (logged)	0.0454		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0855	Mean in Log Scale	-2.489
SD in Original Scale	0.0204	SD in Log Scale	0.252
95% t UCL (Assumes normality)	0.09	95% H-Stat UCL	0.0908

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.0787	95% GROS Approximate Gamma UCL	0.0782

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/L)

General Statistics

Total Number of Observations	105	Number of Distinct Observations	27
Number of Detects	36	Number of Non-Detects	69
Number of Distinct Detects	25	Number of Distinct Non-Detects	4
Minimum Detect	1.4000E-5	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.0152	Maximum Non-Detect	0.005
Variance Detects	1.0850E-5	Percent Non-Detects	65.71%
Mean Detects	0.0018	SD Detects	0.00329
Median Detects	6.5000E-4	CV Detects	1.826
Skewness Detects	3.115	Kurtosis Detects	9.762
Mean of Logged Detects	-7.221	SD of Logged Detects	1.311

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.523	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.935	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.366	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.145	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.3849E-4	KM Standard Error of Mean	2.1224E-4
KM SD	0.00205	95% KM (BCA) UCL	0.00134
95% KM (t) UCL	0.00129	95% KM (Percentile Bootstrap) UCL	0.00133
95% KM (z) UCL	0.00129	95% KM Bootstrap t UCL	0.00153
90% KM Chebyshev UCL	0.00158	95% KM Chebyshev UCL	0.00186
97.5% KM Chebyshev UCL	0.00226	99% KM Chebyshev UCL	0.00305

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.505	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.795	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.24	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.153	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.673	k star (bias corrected MLE)	0.636
Theta hat (MLE)	0.00268	Theta star (bias corrected MLE)	0.00284
nu hat (MLE)	48.48	nu star (bias corrected)	45.77
Mean (detects)	0.0018		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.4000E-5	Mean	0.00719
Maximum	0.0152	Median	0.01
SD	0.00435	CV	0.605
k hat (MLE)	1.016	k star (bias corrected MLE)	0.994
Theta hat (MLE)	0.00707	Theta star (bias corrected MLE)	0.00723
nu hat (MLE)	213.5	nu star (bias corrected)	208.7
Adjusted Level of Significance (β)	0.0477		
Approximate Chi Square Value (208.69, α)	176.3	Adjusted Chi Square Value (208.69, β)	175.9
95% Gamma Approximate UCL (use when n>=50)	0.00851	95% Gamma Adjusted UCL (use when n<50)	0.00853

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.3849E-4	SD (KM)	0.00205
Variance (KM)	4.2110E-6	SE of Mean (KM)	2.1224E-4
k hat (KM)	0.209	k star (KM)	0.21
nu hat (KM)	43.92	nu star (KM)	44
theta hat (KM)	0.00449	theta star (KM)	0.00448
80% gamma percentile (KM)	0.00127	90% gamma percentile (KM)	0.00284
95% gamma percentile (KM)	0.00478	99% gamma percentile (KM)	0.0101

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (44.00, α)	29.79	Adjusted Chi Square Value (44.00, β)	29.63
95% Gamma Approximate KM-UCL (use when n>=50)	0.00139	95% Gamma Adjusted KM-UCL (use when n<50)	0.00139

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.935	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.145	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.5982E-4	Mean in Log Scale	-7.831
SD in Original Scale	0.00207	SD in Log Scale	1.268
95% t UCL (assumes normality of ROS data)	0.00129	95% Percentile Bootstrap UCL	0.00133
95% BCA Bootstrap UCL	0.00144	95% Bootstrap t UCL	0.00156
95% H-UCL (Log ROS)	0.00121		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.957	KM Geo Mean	3.5003E-4
KM SD (logged)	1.524	95% Critical H Value (KM-Log)	2.746
KM Standard Error of Mean (logged)	0.241	95% H-UCL (KM -Log)	0.00169
KM SD (logged)	1.524	95% Critical H Value (KM-Log)	2.746
KM Standard Error of Mean (logged)	0.241		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00184	Mean in Log Scale	-6.827
SD in Original Scale	0.00207	SD in Log Scale	1.179
95% t UCL (Assumes normality)	0.00217	95% H-Stat UCL	0.00286

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

KM H-UCL	0.0016[illegible]

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/L)

General Statistics

Total Number of Observations	63	Number of Distinct Observations	8
Number of Detects	5	Number of Non-Detects	58
Number of Distinct Detects	4	Number of Distinct Non-Detects	5
Minimum Detect	0.0011	Minimum Non-Detect	0.001
Maximum Detect	0.012	Maximum Non-Detect	0.05
Variance Detects	1.6412E-5	Percent Non-Detects	92.06%
Mean Detects	0.00682	SD Detects	0.00405
Median Detects	0.006	CV Detects	0.594
Skewness Detects	-0.244	Kurtosis Detects	0.418
Mean of Logged Detects	-5.236	SD of Logged Detects	0.929

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.22	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0016[illegible]	KM Standard Error of Mean	3.7202E-4
KM SD	0.00216	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00231	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0023	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00281	95% KM Chebyshev UCL	0.00331
97.5% KM Chebyshev UCL	0.00401	99% KM Chebyshev UCL	0.00539

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.43	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.684	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.318	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.171	k star (bias corrected MLE)	1.002
Theta hat (MLE)	0.00314	Theta star (bias corrected MLE)	0.00681
nu hat (MLE)	21.71	nu star (bias corrected)	10.02
Mean (detects)	0.00682		

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.00975
Maximum	0.012	Median	0.01
SD	0.00135	CV	0.138
k hat (MLE)	20.6	k star (bias corrected MLE)	19.63
Theta hat (MLE)	4.7320E-4	Theta star (bias corrected MLE)	4.9660E-4
nu hat (MLE)	2595	nu star (bias corrected)	2473
Adjusted Level of Significance (β)	0.0462		
Approximate Chi Square Value (N/A, α)	2359	Adjusted Chi Square Value (N/A, β)	2356
95% Gamma Approximate UCL (use when n>=50)	0.0102	95% Gamma Adjusted UCL (use when n<50)	0.0102

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00169	SD (KM)	0.00216
Variance (KM)	4.6804E-6	SE of Mean (KM)	3.7202E-4
k hat (KM)	0.61	k star (KM)	0.592
nu hat (KM)	76.92	nu star (KM)	74.59
theta hat (KM)	0.00277	theta star (KM)	0.00286
80% gamma percentile (KM)	0.00279	90% gamma percentile (KM)	0.00441
95% gamma percentile (KM)	0.00611	99% gamma percentile (KM)	0.0102

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (74.59, α)	55.7	Adjusted Chi Square Value (74.59, β)	55.32
95% Gamma Approximate KM-UCL (use when n>=50)	0.00226	95% Gamma Adjusted KM-UCL (use when n<50)	0.00228

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.351	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00113	Mean in Log Scale	-7.831
SD in Original Scale	0.00214	SD in Log Scale	1.439
95% t UCL (assumes normality of ROS data)	0.00158	95% Percentile Bootstrap UCL	0.00161
95% BCA Bootstrap UCL	0.00172	95% Bootstrap t UCL	0.00189
95% H-UCL (Log ROS)	0.00173		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.699	KM Geo Mean	0.00123
KM SD (logged)	0.61	95% Critical H Value (KM-Log)	1.939
KM Standard Error of Mean (logged)	0.109	95% H-UCL (KM -Log)	0.00173
KM SD (logged)	0.61	95% Critical H Value (KM-Log)	1.939
KM Standard Error of Mean (logged)	0.109		

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00386	Mean in Log Scale	-5.899
SD in Original Scale	0.00349	SD in Log Scale	0.91
95% t UCL (Assumes normality)	0.00459	95% H-Stat UCL	0.00535

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.00231

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/L)

General Statistics

Total Number of Observations	53	Number of Distinct Observations	8
Number of Detects	4	Number of Non-Detects	49
Number of Distinct Detects	4	Number of Distinct Non-Detects	4
Minimum Detect	8.0000E-4	Minimum Non-Detect	6.0000E-4
Maximum Detect	0.004	Maximum Non-Detect	0.05
Variance Detects	2.5267E-6	Percent Non-Detects	92.45%
Mean Detects	0.0025	SD Detects	0.00159
Median Detects	0.0026	CV Detects	0.636
Skewness Detects	-0.134	Kurtosis Detects	-4.891
Mean of Logged Detects	-6.189	SD of Logged Detects	0.77

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.87	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.275	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00129	KM Standard Error of Mean	4.2986E-4
KM SD	0.00123	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00201	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.002	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00258	95% KM Chebyshev UCL	0.00316
97.5% KM Chebyshev UCL	0.00398	99% KM Chebyshev UCL	0.00557

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.401	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.312	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.397	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.692	k star (bias corrected MLE)	0.84
Theta hat (MLE)	9.2854E-4	Theta star (bias corrected MLE)	0.00298
nu hat (MLE)	21.54	nu star (bias corrected)	6.718
Mean (detects)	0.0025		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.0000E-4	Mean	0.00943
Maximum	0.01	Median	0.01
SD	0.00204	CV	0.216
k hat (MLE)	8.329	k star (bias corrected MLE)	7.87
Theta hat (MLE)	0.00113	Theta star (bias corrected MLE)	0.0012
nu hat (MLE)	882.9	nu star (bias corrected)	834.3
Adjusted Level of Significance (β)	0.0455		
Approximate Chi Square Value (834.26, α)	768.2	Adjusted Chi Square Value (834.26, β)	766.5
95% Gamma Approximate UCL (use when n>=50)	0.0102	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00129	SD (KM)	0.00123
Variance (KM)	1.5245E-6	SE of Mean (KM)	4.2986E-4
k hat (KM)	1.093	k star (KM)	1.044
nu hat (KM)	115.9	nu star (KM)	110.6
theta hat (KM)	0.00118	theta star (KM)	0.00124
80% gamma percentile (KM)	0.00207	90% gamma percentile (KM)	0.00294
95% gamma percentile (KM)	0.00381	99% gamma percentile (KM)	0.00582

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (110.65, α)	87.37	Adjusted Chi Square Value (110.65, β)	86.79
95% Gamma Approximate KM-UCL (use when n>=50)	0.00163	95% Gamma Adjusted KM-UCL (use when n<50)	0.00165

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.278	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00107	Mean in Log Scale	-7.936
SD in Original Scale	0.00175	SD in Log Scale	1.583
95% t UCL (assumes normality of ROS data)	0.00147	95% Percentile Bootstrap UCL	0.00148
95% BCA Bootstrap UCL	0.00156	95% Bootstrap t UCL	0.00167
95% H-UCL (Log ROS)	0.00245		

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.971	KM Geo Mean	9.3845E-4
KM SD (logged)	0.715	95% Critical H Value (KM-Log)	2.042
KM Standard Error of Mean (logged)	0.249	95% H-UCL (KM -Log)	0.00148
KM SD (logged)	0.715	95% Critical H Value (KM-Log)	2.042
KM Standard Error of Mean (logged)	0.249		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0134	Mean in Log Scale	-5.131
SD in Original Scale	0.0116	SD in Log Scale	1.605
95% t UCL (Assumes normality)	0.0161	95% H-Stat UCL	0.0426

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.00201

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/L)

General Statistics

Total Number of Observations	63	Number of Distinct Observations	22
Number of Detects	21	Number of Non-Detects	42
Number of Distinct Detects	18	Number of Distinct Non-Detects	4
Minimum Detect	0.0011	Minimum Non-Detect	0.005
Maximum Detect	0.0505	Maximum Non-Detect	0.05
Variance Detects	3.2686E-4	Percent Non-Detects	66.67%
Mean Detects	0.013	SD Detects	0.0181
Median Detects	0.0032	CV Detects	1.395
Skewness Detects	1.467	Kurtosis Detects	0.515
Mean of Logged Detects	-5.284	SD of Logged Detects	1.388

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.667	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.322	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00613	KM Standard Error of Mean	0.00156
KM SD	0.0116	95% KM (BCA) UCL	0.00895
95% KM (t) UCL	0.00874	95% KM (Percentile Bootstrap) UCL	0.00886
95% KM (z) UCL	0.0087	95% KM Bootstrap t UCL	0.00972
90% KM Chebyshev UCL	0.0108	95% KM Chebyshev UCL	0.0129
97.5% KM Chebyshev UCL	0.0159	99% KM Chebyshev UCL	0.0217

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.571	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.792	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.198	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.651	k star (bias corrected MLE)	0.59
Theta hat (MLE)	0.0199	Theta star (bias corrected MLE)	0.022
nu hat (MLE)	27.35	nu star (bias corrected)	24.78
Mean (detects)	0.013		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0011	Mean	0.0114
Maximum	0.0505	Median	0.01
SD	0.0105	CV	0.922
k hat (MLE)	1.683	k star (bias corrected MLE)	1.613
Theta hat (MLE)	0.00675	Theta star (bias corrected MLE)	0.00704
nu hat (MLE)	212	nu star (bias corrected)	203.2
Adjusted Level of Significance (β)	0.0462		
Approximate Chi Square Value (203.25, α)	171.3	Adjusted Chi Square Value (203.25, β)	170.6
95% Gamma Approximate UCL (use when n>=50)	0.0135	95% Gamma Adjusted UCL (use when n<50)	0.0135

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00613	SD (KM)	0.0116
Variance (KM)	1.3440E-4	SE of Mean (KM)	0.00156
k hat (KM)	0.28	k star (KM)	0.277
nu hat (KM)	35.24	nu star (KM)	34.89
theta hat (KM)	0.0219	theta star (KM)	0.0221
80% gamma percentile (KM)	0.0092	90% gamma percentile (KM)	0.0182
95% gamma percentile (KM)	0.0288	99% gamma percentile (KM)	0.0564

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (34.89, α)	22.38	Adjusted Chi Square Value (34.89, β)	22.15
95% Gamma Approximate KM-UCL (use when n>=50)	0.00956	95% Gamma Adjusted KM-UCL (use when n<50)	0.00966

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.87	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00646	Mean in Log Scale	-5.826
SD in Original Scale	0.0115	SD in Log Scale	1.143
95% t UCL (assumes normality of ROS data)	0.00888	95% Percentile Bootstrap UCL	0.00893
95% BCA Bootstrap UCL	0.00972	95% Bootstrap t UCL	0.01
95% H-UCL (Log ROS)	0.00788		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.885	KM Geo Mean	0.00278
KM SD (logged)	1.026	95% Critical H Value (KM-Log)	2.263
KM Standard Error of Mean (logged)	0.17	95% H-UCL (KM -Log)	0.00632
KM SD (logged)	1.026	95% Critical H Value (KM-Log)	2.263
KM Standard Error of Mean (logged)	0.17		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0098	Mean in Log Scale	-5.16
SD in Original Scale	0.0115	SD in Log Scale	1.041
95% t UCL (Assumes normality)	0.0122	95% H-Stat UCL	0.0133

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.00632

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/L)

General Statistics

Total Number of Observations	56	Number of Distinct Observations	54
Number of Detects	55	Number of Non-Detects	1
Number of Distinct Detects	53	Number of Distinct Non-Detects	1
Minimum Detect	0.056	Minimum Non-Detect	0.1
Maximum Detect	11	Maximum Non-Detect	0.1
Variance Detects	3.263	Percent Non-Detects	1.786%
Mean Detects	1.319	SD Detects	1.806
Median Detects	0.806	CV Detects	1.369
Skewness Detects	3.751	Kurtosis Detects	16.57
Mean of Logged Detects	-0.232	SD of Logged Detects	0.999

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.581	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.119	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.297	KM Standard Error of Mean	0.24
KM SD	1.782	95% KM (BCA) UCL	1.738
95% KM (t) UCL	1.699	95% KM (Percentile Bootstrap) UCL	1.717
95% KM (z) UCL	1.692	95% KM Bootstrap t UCL	1.987
90% KM Chebyshev UCL	2.018	95% KM Chebyshev UCL	2.344
97.5% KM Chebyshev UCL	2.797	99% KM Chebyshev UCL	3.687

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.427	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.777	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.142	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.123	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.12	k star (bias corrected MLE)	1.071
Theta hat (MLE)	1.178	Theta star (bias corrected MLE)	1.232
nu hat (MLE)	123.1	nu star (bias corrected)	117.8
Mean (detects)	1.319		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.296
Maximum	11	Median	0.766
SD	1.798	CV	1.388
k hat (MLE)	1.013	k star (bias corrected MLE)	0.97
Theta hat (MLE)	1.28	Theta star (bias corrected MLE)	1.336
nu hat (MLE)	113.4	nu star (bias corrected)	108.7
Adjusted Level of Significance (β)	0.0457		
Approximate Chi Square Value (108.66, α)	85.61	Adjusted Chi Square Value (108.66, β)	85.07
95% Gamma Approximate UCL (use when n>=50)	1.645	95% Gamma Adjusted UCL (use when n<50)	1.655

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.297	SD (KM)	1.782
Variance (KM)	3.174	SE of Mean (KM)	0.24
k hat (KM)	0.53	k star (KM)	0.513
nu hat (KM)	59.34	nu star (KM)	57.5
theta hat (KM)	2.447	theta star (KM)	2.526
80% gamma percentile (KM)	2.132	90% gamma percentile (KM)	3.489
95% gamma percentile (KM)	4.935	99% gamma percentile (KM)	8.481

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (57.50, α)	41.07	Adjusted Chi Square Value (57.50, β)	40.7
95% Gamma Approximate KM-UCL (use when n>=50)	1.816	95% Gamma Adjusted KM-UCL (use when n<50)	1.832

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.982	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.783	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0999	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.119	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.297	Mean in Log Scale	-0.269
SD in Original Scale	1.797	SD in Log Scale	1.028
95% t UCL (assumes normality of ROS data)	1.699	95% Percentile Bootstrap UCL	1.734
95% BCA Bootstrap UCL	1.9	95% Bootstrap t UCL	1.992
95% H-UCL (Log ROS)	1.801		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.276	KM Geo Mean	0.758
KM SD (logged)	1.035	95% Critical H Value (KM-Log)	2.379
KM Standard Error of Mean (logged)	0.14	95% H-UCL (KM -Log)	1.806
KM SD (logged)	1.035	95% Critical H Value (KM-Log)	2.379
KM Standard Error of Mean (logged)	0.14		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.296	Mean in Log Scale	-0.281
SD in Original Scale	1.798	SD in Log Scale	1.057
95% t UCL (Assumes normality)	1.698	95% H-Stat UCL	1.859

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	1.806

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/L)

General Statistics

Total Number of Observations	104	Number of Distinct Observations	38
Number of Detects	48	Number of Non-Detects	56
Number of Distinct Detects	37	Number of Distinct Non-Detects	3
Minimum Detect	5.0000E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.067	Maximum Non-Detect	0.01
Variance Detects	1.3321E-4	Percent Non-Detects	53.85%
Mean Detects	0.00821	SD Detects	0.0115
Median Detects	0.00345	CV Detects	1.406
Skewness Detects	3.386	Kurtosis Detects	14.24
Mean of Logged Detects	-5.372	SD of Logged Detects	1.026

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.607	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.292	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.127	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00539	KM Standard Error of Mean	8.4121E-4
KM SD	0.00829	95% KM (BCA) UCL	0.00686
95% KM (t) UCL	0.00679	95% KM (Percentile Bootstrap) UCL	0.00684
95% KM (z) UCL	0.00678	95% KM Bootstrap t UCL	0.00763
90% KM Chebyshev UCL	0.00792	95% KM Chebyshev UCL	0.00906
97.5% KM Chebyshev UCL	0.0106	99% KM Chebyshev UCL	0.0138

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.304	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.778	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.2	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.132	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.012	k star (bias corrected MLE)	0.962
Theta hat (MLE)	0.00811	Theta star (bias corrected MLE)	0.00853
nu hat (MLE)	97.11	nu star (bias corrected)	92.38
Mean (detects)	0.00821		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.0000E-4	Mean	0.00928
Maximum	0.067	Median	0.01
SD	0.00788	CV	0.849
k hat (MLE)	2.001	k star (bias corrected MLE)	1.95
Theta hat (MLE)	0.00464	Theta star (bias corrected MLE)	0.00476
nu hat (MLE)	416.2	nu star (bias corrected)	405.6
Adjusted Level of Significance (β)	0.0477		
Approximate Chi Square Value (405.57, α)	359.9	Adjusted Chi Square Value (405.57, β)	359.3
95% Gamma Approximate UCL (use when n>=50)	0.0105	95% Gamma Adjusted UCL (use when n<50)	0.0105

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00539	SD (KM)	0.00829
Variance (KM)	6.8728E-5	SE of Mean (KM)	8.4121E-4
k hat (KM)	0.423	k star (KM)	0.418
nu hat (KM)	88.07	nu star (KM)	86.86
theta hat (KM)	0.0127	theta star (KM)	0.0129
80% gamma percentile (KM)	0.00875	90% gamma percentile (KM)	0.0151
95% gamma percentile (KM)	0.0221	99% gamma percentile (KM)	0.0395

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (86.86, α)	66.38	Adjusted Chi Square Value (86.86, β)	66.13
95% Gamma Approximate KM-UCL (use when n>=50)	0.00706	95% Gamma Adjusted KM-UCL (use when n<50)	0.00709

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.148	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00554	Mean in Log Scale	-5.726
SD in Original Scale	0.00837	SD in Log Scale	0.979
95% t UCL (assumes normality of ROS data)	0.0069	95% Percentile Bootstrap UCL	0.00701
95% BCA Bootstrap UCL	0.00743	95% Bootstrap t UCL	0.00764
95% H-UCL (Log ROS)	0.0065		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.735	KM Geo Mean	0.00323
KM SD (logged)	0.949	95% Critical H Value (KM-Log)	2.162
KM Standard Error of Mean (logged)	0.122	95% H-UCL (KM -Log)	0.0062
KM SD (logged)	0.949	95% Critical H Value (KM-Log)	2.162
KM Standard Error of Mean (logged)	0.122		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00617	Mean in Log Scale	-5.45
SD in Original Scale	0.00807	SD in Log Scale	0.822
95% t UCL (Assumes normality)	0.00749	95% H-Stat UCL	0.00711

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.0062

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/L)

General Statistics

Total Number of Observations	63	Number of Distinct Observations	58
Number of Detects	62	Number of Non-Detects	1
Number of Distinct Detects	57	Number of Distinct Non-Detects	1

Minimum Detect	0.017	Minimum Non-Detect	0.015
Maximum Detect	1.23	Maximum Non-Detect	0.015
Variance Detects	0.029	Percent Non-Detects	1.587%
Mean Detects	0.171	SD Detects	0.17
Median Detects	0.136	CV Detects	0.994
Skewness Detects	4.318	Kurtosis Detects	24.63
Mean of Logged Detects	-2.044	SD of Logged Detects	0.739

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.626	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.224	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.169	KM Standard Error of Mean	0.0214
KM SD	0.169	95% KM (BCA) UCL	0.212
95% KM (t) UCL	0.205	95% KM (Percentile Bootstrap) UCL	0.207
95% KM (z) UCL	0.204	95% KM Bootstrap t UCL	0.228
90% KM Chebyshev UCL	0.233	95% KM Chebyshev UCL	0.262
97.5% KM Chebyshev UCL	0.303	99% KM Chebyshev UCL	0.382

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.823	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.764	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.112	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.115	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.937	k star (bias corrected MLE)	1.854
Theta hat (MLE)	0.0885	Theta star (bias corrected MLE)	0.0924
nu hat (MLE)	240.2	nu star (bias corrected)	229.9
Mean (detects)	0.171		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.169
Maximum	1.23	Median	0.13
SD	0.17	CV	1.009
k hat (MLE)	1.786	k star (bias corrected MLE)	1.711
Theta hat (MLE)	0.0945	Theta star (bias corrected MLE)	0.0987
nu hat (MLE)	225	nu star (bias corrected)	215.6
Adjusted Level of Significance (β)	0.0462		
Approximate Chi Square Value (215.62, α)	182.6	Adjusted Chi Square Value (215.62, β)	181.9
95% Gamma Approximate UCL (use when n>=50)	0.199	95% Gamma Adjusted UCL (use when n<50)	0.2

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.169	SD (KM)	0.169
Variance (KM)	0.0285	SE of Mean (KM)	0.0214
k hat (KM)	1.001	k star (KM)	0.964
nu hat (KM)	126.1	nu star (KM)	121.4
theta hat (KM)	0.169	theta star (KM)	0.175
80% gamma percentile (KM)	0.273	90% gamma percentile (KM)	0.392
95% gamma percentile (KM)	0.513	99% gamma percentile (KM)	0.792

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (121.44, α)	96.99	Adjusted Chi Square Value (121.44, β)	96.48
95% Gamma Approximate KM-UCL (use when n>=50)	0.211	95% Gamma Adjusted KM-UCL (use when n<50)	0.213

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.985	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.873	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0742	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.112	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.169	Mean in Log Scale	-2.074
SD in Original Scale	0.17	SD in Log Scale	0.773
95% t UCL (assumes normality of ROS data)	0.205	95% Percentile Bootstrap UCL	0.206
95% BCA Bootstrap UCL	0.215	95% Bootstrap t UCL	0.228
95% H-UCL (Log ROS)	0.207		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.078	KM Geo Mean	0.125
KM SD (logged)	0.776	95% Critical H Value (KM-Log)	2.071
KM Standard Error of Mean (logged)	0.0986	95% H-UCL (KM -Log)	0.207
KM SD (logged)	0.776	95% Critical H Value (KM-Log)	2.071
KM Standard Error of Mean (logged)	0.0986		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.169	Mean in Log Scale	-2.089
SD in Original Scale	0.17	SD in Log Scale	0.817
95% t UCL (Assumes normality)	0.205	95% H-Stat UCL	0.215

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.211	95% GROS Approximate Gamma UCL	0.199

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/L)

General Statistics

Total Number of Observations	38	Number of Distinct Observations	5
Number of Detects	1	Number of Non-Detects	37
Number of Distinct Detects	1	Number of Distinct Non-Detects	4

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Mercury (mg/L) was not processed!

Molybdenum (mg/L)

General Statistics

Total Number of Observations	25	Number of Distinct Observations	7
Number of Detects	2	Number of Non-Detects	23
Number of Distinct Detects	2	Number of Distinct Non-Detects	6
Minimum Detect	6.0000E-4	Minimum Non-Detect	4.0000E-4
Maximum Detect	0.0039	Maximum Non-Detect	0.05
Variance Detects	5.4450E-6	Percent Non-Detects	92%
Mean Detects	0.00225	SD Detects	0.00233
Median Detects	0.00225	CV Detects	1.037
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-6.483	SD of Logged Detects	1.324

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.4848E-4	KM Standard Error of Mean	4.2675E-4
KM SD	9.9913E-4	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.00148	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.00145	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.00203	95% KM Chebyshev UCL	0.00261
97.5% KM Chebyshev UCL	0.00341	99% KM Chebyshev UCL	0.00499

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	1.44	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00156	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	5.759	nu star (bias corrected)	N/A
Mean (detects)	0.00225		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.4848E-4	SD (KM)	9.9913E-4
Variance (KM)	9.9826E-7	SE of Mean (KM)	4.2675E-4
k hat (KM)	0.561	k star (KM)	0.521
nu hat (KM)	28.06	nu star (KM)	26.03
theta hat (KM)	0.00133	theta star (KM)	0.00144
80% gamma percentile (KM)	0.00123	90% gamma percentile (KM)	0.00201
95% gamma percentile (KM)	0.00283	99% gamma percentile (KM)	0.00486

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0395
Approximate Chi Square Value (26.03, α)	15.4	Adjusted Chi Square Value (26.03, β)	14.84
95% Gamma Approximate KM-UCL (use when n>=50)	0.00126	95% Gamma Adjusted KM-UCL (use when n<50)	0.00131

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.5549E-4	Mean in Log Scale	-9.87
SD in Original Scale	8.6688E-4	SD in Log Scale	2.039
95% t UCL (assumes normality of ROS data)	6.5212E-4	95% Percentile Bootstrap UCL	6.6494E-4
95% BCA Bootstrap UCL	8.0956E-4	95% Bootstrap t UCL	0.00146
95% H-UCL (Log ROS)	0.00222		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.556	KM Geo Mean	5.2318E-4
KM SD (logged)	0.651	95% Critical H Value (KM-Log)	2.097
KM Standard Error of Mean (logged)	0.282	95% H-UCL (KM -Log)	8.5480E-4
KM SD (logged)	0.651	95% Critical H Value (KM-Log)	2.097
KM Standard Error of Mean (logged)	0.282		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00258	Mean in Log Scale	-6.724
SD in Original Scale	0.00481	SD in Log Scale	1.249
95% t UCL (Assumes normality)	0.00423	95% H-Stat UCL	0.00539

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.00261

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/L)

General Statistics

Total Number of Observations	63	Number of Distinct Observations	16
Number of Detects	14	Number of Non-Detects	49
Number of Distinct Detects	12	Number of Distinct Non-Detects	4
Minimum Detect	0.00159	Minimum Non-Detect	0.01
Maximum Detect	0.013	Maximum Non-Detect	0.05
Variance Detects	7.5034E-6	Percent Non-Detects	77.78%
Mean Detects	0.00439	SD Detects	0.00274
Median Detects	0.0034	CV Detects	0.624
Skewness Detects	2.67	Kurtosis Detects	8.311
Mean of Logged Detects	-5.55	SD of Logged Detects	0.477

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.681	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.269	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.00399	KM Standard Error of Mean	4.1967E-4
KM SD	0.00191	95% KM (BCA) UCL	0.00469
95% KM (t) UCL	0.00469	95% KM (Percentile Bootstrap) UCL	0.00474
95% KM (z) UCL	0.00468	95% KM Bootstrap t UCL	0.00493
90% KM Chebyshev UCL	0.00524	95% KM Chebyshev UCL	0.00581
97.5% KM Chebyshev UCL	0.00661	99% KM Chebyshev UCL	0.00816

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.975	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.74	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.214	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.23	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.278	k star (bias corrected MLE)	3.409
Theta hat (MLE)	0.00103	Theta star (bias corrected MLE)	0.00129
nu hat (MLE)	119.8	nu star (bias corrected)	95.44
Mean (detects)	0.00439		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00159	Mean	0.00875
Maximum	0.013	Median	0.01
SD	0.00266	CV	0.304
k hat (MLE)	6.675	k star (bias corrected MLE)	6.367
Theta hat (MLE)	0.00131	Theta star (bias corrected MLE)	0.00137
nu hat (MLE)	841	nu star (bias corrected)	802.3
Adjusted Level of Significance (β)	0.0462		
Approximate Chi Square Value (802.30, α)	737.6	Adjusted Chi Square Value (802.30, β)	736.1
95% Gamma Approximate UCL (use when n>=50)	0.00952	95% Gamma Adjusted UCL (use when n<50)	0.00954

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.00399	SD (KM)	0.00191
Variance (KM)	3.6463E-6	SE of Mean (KM)	4.1967E-4
k hat (KM)	4.356	k star (KM)	4.159
nu hat (KM)	548.8	nu star (KM)	524
theta hat (KM)	9.1494E-4	theta star (KM)	9.5824E-4
80% gamma percentile (KM)	0.00547	90% gamma percentile (KM)	0.0066
95% gamma percentile (KM)	0.00765	99% gamma percentile (KM)	0.00987

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (524.02, α)	471.9	Adjusted Chi Square Value (524.02, β)	470.8
95% Gamma Approximate KM-UCL (use when n>=50)	0.00443	95% Gamma Adjusted KM-UCL (use when n<50)	0.00444

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.222	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00404	Mean in Log Scale	-5.598
SD in Original Scale	0.00186	SD in Log Scale	0.409
95% t UCL (assumes normality of ROS data)	0.00443	95% Percentile Bootstrap UCL	0.00444
95% BCA Bootstrap UCL	0.00446	95% Bootstrap t UCL	0.00455
95% H-UCL (Log ROS)	0.00443		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.607	KM Geo Mean	0.00367
KM SD (logged)	0.386	95% Critical H Value (KM-Log)	1.796
KM Standard Error of Mean (logged)	0.0986	95% H-UCL (KM -Log)	0.00432
KM SD (logged)	0.386	95% Critical H Value (KM-Log)	1.796
KM Standard Error of Mean (logged)	0.0986		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0112	Mean in Log Scale	-4.768
SD in Original Scale	0.00775	SD in Log Scale	0.775
95% t UCL (Assumes normality)	0.0128	95% H-Stat UCL	0.0141

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.00443	95% GROS Approximate Gamma UCL	0.00952

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/L)

General Statistics

Total Number of Observations	53	Number of Distinct Observations	6
Number of Detects	8	Number of Non-Detects	45
Number of Distinct Detects	2	Number of Distinct Non-Detects	5
Minimum Detect	4.0000E-4	Minimum Non-Detect	4.0000E-4
Maximum Detect	5.0000E-4	Maximum Non-Detect	0.035
Variance Detects	2.6786E-9	Percent Non-Detects	84.91%
Mean Detects	4.6250E-4	SD Detects	5.1755E-5
Median Detects	5.0000E-4	CV Detects	0.112
Skewness Detects	-0.644	Kurtosis Detects	-2.24
Mean of Logged Detects	-7.685	SD of Logged Detects	0.115

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.641	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.391	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	4.4545E-4	KM Standard Error of Mean	1.6050E-5
KM SD	4.9793E-5	95% KM (BCA) UCL	N/A
95% KM (t) UCL	4.7233E-4	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	4.7185E-4	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	4.9360E-4	95% KM Chebyshev UCL	5.1541E-4
97.5% KM Chebyshev UCL	5.4569E-4	99% KM Chebyshev UCL	6.0515E-4

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.558	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.715	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.406	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.294	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	87.62	k star (bias corrected MLE)	54.85
Theta hat (MLE)	5.2785E-6	Theta star (bias corrected MLE)	8.4327E-6
nu hat (MLE)	1402	nu star (bias corrected)	877.5
Mean (detects)	4.6250E-4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	4.0000E-4	Mean	0.00856
Maximum	0.01	Median	0.01
SD	0.00345	CV	0.403
k hat (MLE)	1.764	k star (bias corrected MLE)	1.677
Theta hat (MLE)	0.00485	Theta star (bias corrected MLE)	0.0051
nu hat (MLE)	187	nu star (bias corrected)	177.8
Adjusted Level of Significance (β)	0.0455		
Approximate Chi Square Value (177.78, α)	147.9	Adjusted Chi Square Value (177.78, β)	147.2
95% Gamma Approximate UCL (use when n>=50)	0.0103	95% Gamma Adjusted UCL (use when n<50)	0.0103

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	4.4545E-4	SD (KM)	4.9793E-5
Variance (KM)	2.4793E-9	SE of Mean (KM)	1.6050E-5
k hat (KM)	80.03	k star (KM)	75.52
nu hat (KM)	8484	nu star (KM)	8005
theta hat (KM)	5.5659E-6	theta star (KM)	5.8988E-6
80% gamma percentile (KM)	4.8792E-4	90% gamma percentile (KM)	5.1228E-4
95% gamma percentile (KM)	5.3299E-4	99% gamma percentile (KM)	5.7330E-4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	7798	Adjusted Chi Square Value (N/A, β)	7792
95% Gamma Approximate KM-UCL (use when n>=50)	4.5728E-4	95% Gamma Adjusted KM-UCL (use when n<50)	4.5761E-4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.641	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.391	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.3532E-4	Mean in Log Scale	-7.748
SD in Original Scale	5.8067E-5	SD in Log Scale	0.134
95% t UCL (assumes normality of ROS data)	4.4867E-4	95% Percentile Bootstrap UCL	4.4864E-4
95% BCA Bootstrap UCL	4.4855E-4	95% Bootstrap t UCL	4.4929E-4
95% H-UCL (Log ROS)	4.4935E-4		

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.723	KM Geo Mean	4.4270E-4
KM SD (logged)	0.111	95% Critical H Value (KM-Log)	1.691
KM Standard Error of Mean (logged)	0.0358	95% H-UCL (KM -Log)	4.5720E-4
KM SD (logged)	0.111	95% Critical H Value (KM-Log)	1.691
KM Standard Error of Mean (logged)	0.0358		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00996	Mean in Log Scale	-5.316
SD in Original Scale	0.00757	SD in Log Scale	1.567
95% t UCL (Assumes normality)	0.0117	95% H-Stat UCL	0.0325

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	4.7233E-4	KM H-UCL	4.5720E-4
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silica (as SIO2) (mg/L)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	15.1	Mean	15.1
Maximum	15.1	Median	15.1

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Silica (as SIO2) (mg/L) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Sodium (mg/L)

General Statistics

Total Number of Observations	50	Number of Distinct Observations	30
Number of Detects	43	Number of Non-Detects	7
Number of Distinct Detects	30	Number of Distinct Non-Detects	1

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	3	Minimum Non-Detect	5
Maximum Detect	25.5	Maximum Non-Detect	5
Variance Detects	43.14	Percent Non-Detects	14%
Mean Detects	12.21	SD Detects	6.568
Median Detects	10	CV Detects	0.538
Skewness Detects	0.669	Kurtosis Detects	-0.974
Mean of Logged Detects	2.36	SD of Logged Detects	0.546

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.876	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.943	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.187	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.134	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	10.92	KM Standard Error of Mean	0.975
KM SD	6.815	95% KM (BCA) UCL	12.96
95% KM (t) UCL	12.56	95% KM (Percentile Bootstrap) UCL	12.63
95% KM (z) UCL	12.53	95% KM Bootstrap t UCL	12.57
90% KM Chebyshev UCL	13.85	95% KM Chebyshev UCL	15.17
97.5% KM Chebyshev UCL	17.01	99% KM Chebyshev UCL	20.63

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.114	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.124	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.136	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.664	k star (bias corrected MLE)	3.424
Theta hat (MLE)	3.333	Theta star (bias corrected MLE)	3.567
nu hat (MLE)	315.1	nu star (bias corrected)	294.4
Mean (detects)	12.21		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.048	Mean	10.78
Maximum	25.5	Median	9
SD	7.071	CV	0.656
k hat (MLE)	1.715	k star (bias corrected MLE)	1.626
Theta hat (MLE)	6.285	Theta star (bias corrected MLE)	6.632
nu hat (MLE)	171.5	nu star (bias corrected)	162.6
Adjusted Level of Significance (β)	0.0452		
Approximate Chi Square Value (162.55, α)	134.1	Adjusted Chi Square Value (162.55, β)	133.3
95% Gamma Approximate UCL (use when n>=50)	13.07	95% Gamma Adjusted UCL (use when n<50)	13.14

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	10.92	SD (KM)	6.815
Variance (KM)	46.45	SE of Mean (KM)	0.975
k hat (KM)	2.568	k star (KM)	2.427
nu hat (KM)	256.8	nu star (KM)	242.7
theta hat (KM)	4.253	theta star (KM)	4.5
80% gamma percentile (KM)	15.98	90% gamma percentile (KM)	20.31
95% gamma percentile (KM)	24.4	99% gamma percentile (KM)	33.36

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (242.71, α)	207.6	Adjusted Chi Square Value (242.71, β)	206.7
95% Gamma Approximate KM-UCL (use when n>=50)	12.77	95% Gamma Adjusted KM-UCL (use when n<50)	12.83

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.943	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.12	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.134	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	10.98	Mean in Log Scale	2.197
SD in Original Scale	6.828	SD in Log Scale	0.655
95% t UCL (assumes normality of ROS data)	12.59	95% Percentile Bootstrap UCL	12.58
95% BCA Bootstrap UCL	12.59	95% Bootstrap t UCL	12.7
95% H-UCL (Log ROS)	13.45		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.183	KM Geo Mean	8.874
KM SD (logged)	0.665	95% Critical H Value (KM-Log)	2.013
KM Standard Error of Mean (logged)	0.0951	95% H-UCL (KM -Log)	13.4
KM SD (logged)	0.665	95% Critical H Value (KM-Log)	2.013
KM Standard Error of Mean (logged)	0.0951		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	10.85	Mean in Log Scale	2.158
SD in Original Scale	6.969	SD in Log Scale	0.715
95% t UCL (Assumes normality)	12.5	95% H-Stat UCL	13.78

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	12.77	95% GROS Approximate Gamma UCL	13.07

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium (mg/L)

General Statistics

Total Number of Observations	38	Number of Distinct Observations	4
Number of Detects	1	Number of Non-Detects	37
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Thallium (mg/L) was not processed!

Vanadium (mg/L)

General Statistics

Total Number of Observations	38	Number of Distinct Observations	12
Number of Detects	11	Number of Non-Detects	27
Number of Distinct Detects	9	Number of Distinct Non-Detects	3
Minimum Detect	5.0000E-4	Minimum Non-Detect	0.02
Maximum Detect	0.0026	Maximum Non-Detect	0.05
Variance Detects	5.4400E-7	Percent Non-Detects	71.05%
Mean Detects	0.0018	SD Detects	7.3756E-4
Median Detects	0.0022	CV Detects	0.41
Skewness Detects	-0.729	Kurtosis Detects	-1.059
Mean of Logged Detects	-6.431	SD of Logged Detects	0.545

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.87	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.252	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0018	KM Standard Error of Mean	2.2238E-4
KM SD	7.0324E-4	95% KM (BCA) UCL	0.00214
95% KM (t) UCL	0.00218	95% KM (Percentile Bootstrap) UCL	0.00215
95% KM (z) UCL	0.00217	95% KM Bootstrap t UCL	0.00214
90% KM Chebyshev UCL	0.00247	95% KM Chebyshev UCL	0.00277
97.5% KM Chebyshev UCL	0.00319	99% KM Chebyshev UCL	0.00401

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.849	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.732	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.286	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.256	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.674	k star (bias corrected MLE)	3.46
Theta hat (MLE)	3.8510E-4	Theta star (bias corrected MLE)	5.2024E-4
nu hat (MLE)	102.8	nu star (bias corrected)	76.12
Mean (detects)	0.0018		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.0000E-4	Mean	0.00763
Maximum	0.01	Median	0.01
SD	0.00379	CV	0.497
k hat (MLE)	2.093	k star (bias corrected MLE)	1.946
Theta hat (MLE)	0.00364	Theta star (bias corrected MLE)	0.00392
nu hat (MLE)	159.1	nu star (bias corrected)	147.9
Adjusted Level of Significance (β)	0.0434		
Approximate Chi Square Value (147.87, α)	120.8	Adjusted Chi Square Value (147.87, β)	119.7
95% Gamma Approximate UCL (use when n>=50)	0.00934	95% Gamma Adjusted UCL (use when n<50)	0.00942

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0018	SD (KM)	7.0324E-4
Variance (KM)	4.9455E-7	SE of Mean (KM)	2.2238E-4
k hat (KM)	6.551	k star (KM)	6.052
nu hat (KM)	497.9	nu star (KM)	459.9
theta hat (KM)	2.7475E-4	theta star (KM)	2.9743E-4
80% gamma percentile (KM)	0.00237	90% gamma percentile (KM)	0.00278
95% gamma percentile (KM)	0.00315	99% gamma percentile (KM)	0.00392

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (459.94, α)	411.2	Adjusted Chi Square Value (459.94, β)	409.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.00201	95% Gamma Adjusted KM-UCL (use when n<50)	0.00202

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.819	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.291	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00182	Mean in Log Scale	-6.431
SD in Original Scale	8.9062E-4	SD in Log Scale	0.514
95% t UCL (assumes normality of ROS data)	0.00206	95% Percentile Bootstrap UCL	0.00207
95% BCA Bootstrap UCL	0.0021	95% Bootstrap t UCL	0.00208
95% H-UCL (Log ROS)	0.00216		

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-6.431	KM Geo Mean	0.00161
KM SD (logged)	0.52	95% Critical H Value (KM-Log)	1.93
KM Standard Error of Mean (logged)	0.164	95% H-UCL (KM -Log)	0.00217
KM SD (logged)	0.52	95% Critical H Value (KM-Log)	1.93
KM Standard Error of Mean (logged)	0.164		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0176	Mean in Log Scale	-4.52
SD in Original Scale	0.0106	SD in Log Scale	1.279
95% t UCL (Assumes normality)	0.0205	95% H-Stat UCL	0.0438

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.00218

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/L)

General Statistics

Total Number of Observations	282	Number of Distinct Observations	177
Number of Detects	277	Number of Non-Detects	5
Number of Distinct Detects	175	Number of Distinct Non-Detects	2
Minimum Detect	0.00326	Minimum Non-Detect	0.06
Maximum Detect	3.82	Maximum Non-Detect	0.0612
Variance Detects	0.105	Percent Non-Detects	1.773%
Mean Detects	0.171	SD Detects	0.323
Median Detects	0.127	CV Detects	1.892
Skewness Detects	8.137	Kurtosis Detects	77.48
Mean of Logged Detects	-2.195	SD of Logged Detects	0.825

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.332	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.323	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0536	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.169	KM Standard Error of Mean	0.0191
KM SD	0.32	95% KM (BCA) UCL	0.203
95% KM (t) UCL	0.2	95% KM (Percentile Bootstrap) UCL	0.203
95% KM (z) UCL	0.2	95% KM Bootstrap t UCL	0.219
90% KM Chebyshev UCL	0.226	95% KM Chebyshev UCL	0.252
97.5% KM Chebyshev UCL	0.288	99% KM Chebyshev UCL	0.359

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	12.2	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.777	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.177	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.056	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.308	k star (bias corrected MLE)	1.296
Theta hat (MLE)	0.131	Theta star (bias corrected MLE)	0.132
nu hat (MLE)	724.4	nu star (bias corrected)	717.9
Mean (detects)	0.171		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00326	Mean	0.168
Maximum	3.82	Median	0.126
SD	0.321	CV	1.911
k hat (MLE)	1.24	k star (bias corrected MLE)	1.229
Theta hat (MLE)	0.136	Theta star (bias corrected MLE)	0.137
nu hat (MLE)	699.2	nu star (bias corrected)	693.1
Adjusted Level of Significance (β)	0.0491		
Approximate Chi Square Value (693.09, α)	633	Adjusted Chi Square Value (693.09, β)	632.7
95% Gamma Approximate UCL (use when n>=50)	0.184	95% Gamma Adjusted UCL (use when n<50)	0.184

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.169	SD (KM)	0.32
Variance (KM)	0.103	SE of Mean (KM)	0.0191
k hat (KM)	0.277	k star (KM)	0.277
nu hat (KM)	156.3	nu star (KM)	156
theta hat (KM)	0.609	theta star (KM)	0.61
80% gamma percentile (KM)	0.253	90% gamma percentile (KM)	0.502
95% gamma percentile (KM)	0.792	99% gamma percentile (KM)	1.553

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (156.02, α)	128.1	Adjusted Chi Square Value (156.02, β)	128
95% Gamma Approximate KM-UCL (use when n>=50)	0.205	95% Gamma Adjusted KM-UCL (use when n<50)	0.206

Appendix D, Table 18. ProUCL Output - Lower Spring River Surface Water (Total)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.945	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	3.205E-12	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0983	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0536	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.169	Mean in Log Scale	-2.213
SD in Original Scale	0.321	SD in Log Scale	0.829
95% t UCL (assumes normality of ROS data)	0.2	95% Percentile Bootstrap UCL	0.203
95% BCA Bootstrap UCL	0.211	95% Bootstrap t UCL	0.223
95% H-UCL (Log ROS)	0.17		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.214	KM Geo Mean	0.109
KM SD (logged)	0.831	95% Critical H Value (KM-Log)	2.003
KM Standard Error of Mean (logged)	0.0498	95% H-UCL (KM -Log)	0.17
KM SD (logged)	0.831	95% Critical H Value (KM-Log)	2.003
KM Standard Error of Mean (logged)	0.0498		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.168	Mean in Log Scale	-2.218
SD in Original Scale	0.321	SD in Log Scale	0.836
95% t UCL (Assumes normality)	0.2	95% H-Stat UCL	0.171

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.252

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 2:31:23 PM
From File	TCOU5 ProUCL Tables 190506_u.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	80
		Number of Missing Observations	0
Minimum	0.61	Mean	4.152
Maximum	21.2	Median	2.893
SD	4.289	Std. Error of Mean	0.48
Coefficient of Variation	1.033	Skewness	2.137

Normal GOF Test

Shapiro Wilk Test Statistic	0.736	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.95	95% Adjusted-CLT UCL (Chen-1995)	5.063
		95% Modified-t UCL (Johnson-1978)	4.969

Gamma GOF Test

A-D Test Statistic	1.56	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.774	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.126	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.102	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.355	k star (bias corrected MLE)	1.313
Theta hat (MLE)	3.064	Theta star (bias corrected MLE)	3.163
nu hat (MLE)	216.8	nu star (bias corrected)	210
MLE Mean (bias corrected)	4.152	MLE Sd (bias corrected)	3.624
		Approximate Chi Square Value (0.05)	177.5
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	176.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.913	95% Adjusted Gamma UCL (use when n<50)	4.928

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0194	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0716	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.494	Mean of logged Data	1.011
Maximum of Logged Data	3.054	SD of logged Data	0.904

Assuming Lognormal Distribution

95% H-UCL	5.16	90% Chebyshev (MVUE) UCL	5.554
95% Chebyshev (MVUE) UCL	6.209	97.5% Chebyshev (MVUE) UCL	7.119
99% Chebyshev (MVUE) UCL	8.906		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.941	95% Jackknife UCL	4.95
95% Standard Bootstrap UCL	4.941	95% Bootstrap-t UCL	5.194
95% Hall's Bootstrap UCL	5.067	95% Percentile Bootstrap UCL	4.981
95% BCA Bootstrap UCL	5.047		
90% Chebyshev(Mean, Sd) UCL	5.591	95% Chebyshev(Mean, Sd) UCL	6.242
97.5% Chebyshev(Mean, Sd) UCL	7.147	99% Chebyshev(Mean, Sd) UCL	8.923

Suggested UCL to Use

95% H-UCL 5.16

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Antimony (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	33
Number of Detects	11	Number of Non-Detects	69
Number of Distinct Detects	11	Number of Distinct Non-Detects	22

Minimum Detect	0.243	Minimum Non-Detect	0.232
Maximum Detect	0.32	Maximum Non-Detect	0.469
Variance Detects	6.9929E-4	Percent Non-Detects	86.25%
Mean Detects	0.273	SD Detects	0.0264
Median Detects	0.26	CV Detects	0.0969
Skewness Detects	0.837	Kurtosis Detects	-0.721
Mean of Logged Detects	-1.302	SD of Logged Detects	0.0942

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.875	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.238	KM Standard Error of Mean	0.00225
KM SD	0.0179	95% KM (BCA) UCL	0.245
95% KM (t) UCL	0.242	95% KM (Percentile Bootstrap) UCL	0.243
95% KM (z) UCL	0.242	95% KM Bootstrap t UCL	0.242
90% KM Chebyshev UCL	0.245	95% KM Chebyshev UCL	0.248
97.5% KM Chebyshev UCL	0.252	99% KM Chebyshev UCL	0.261

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.629	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.726	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.244	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.254	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	121.8	k star (bias corrected MLE)	88.63
Theta hat (MLE)	0.00224	Theta star (bias corrected MLE)	0.00308
nu hat (MLE)	2679	nu star (bias corrected)	1950
Mean (detects)	0.273		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0762	Mean	0.188
Maximum	0.32	Median	0.184
SD	0.0475	CV	0.253
k hat (MLE)	15.29	k star (bias corrected MLE)	14.72
Theta hat (MLE)	0.0123	Theta star (bias corrected MLE)	0.0127
nu hat (MLE)	2446	nu star (bias corrected)	2356
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (N/A, α)	2244	Adjusted Chi Square Value (N/A, β)	2242
95% Gamma Approximate UCL (use when n>=50)	0.197	95% Gamma Adjusted UCL (use when n<50)	0.197

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.238	SD (KM)	0.0179
Variance (KM)	3.2217E-4	SE of Mean (KM)	0.00225
k hat (KM)	176.2	k star (KM)	169.6
nu hat (KM)	28199	nu star (KM)	27143
theta hat (KM)	0.00135	theta star (KM)	0.0014
80% gamma percentile (KM)	0.254	90% gamma percentile (KM)	0.262
95% gamma percentile (KM)	0.269	99% gamma percentile (KM)	0.283

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	26761	Adjusted Chi Square Value (N/A, β)	26754
95% Gamma Approximate KM-UCL (use when n>=50)	0.242	95% Gamma Adjusted KM-UCL (use when n<50)	0.242

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.887	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.2	Mean in Log Scale	-1.626
SD in Original Scale	0.0383	SD in Log Scale	0.185
95% t UCL (assumes normality of ROS data)	0.207	95% Percentile Bootstrap UCL	0.207
95% BCA Bootstrap UCL	0.208	95% Bootstrap t UCL	0.208
95% H-UCL (Log ROS)	0.207		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.437	KM Geo Mean	0.238
KM SD (logged)	0.068	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.00852	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.068	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.00852		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.149	Mean in Log Scale	-1.955
SD in Original Scale	0.0546	SD in Log Scale	0.295
95% t UCL (Assumes normality)	0.159	95% H-Stat UCL	0.157

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.242

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Arsenic (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	33
Number of Detects	24	Number of Non-Detects	56
Number of Distinct Detects	24	Number of Distinct Non-Detects	9
Minimum Detect	0.274	Minimum Non-Detect	0.266
Maximum Detect	0.724	Maximum Non-Detect	0.722
Variance Detects	0.0133	Percent Non-Detects	70%
Mean Detects	0.373	SD Detects	0.115
Median Detects	0.333	CV Detects	0.31
Skewness Detects	2.064	Kurtosis Detects	4.432
Mean of Logged Detects	-1.023	SD of Logged Detects	0.26

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.746	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.3	KM Standard Error of Mean	0.00925
KM SD	0.0796	95% KM (BCA) UCL	0.319
95% KM (t) UCL	0.315	95% KM (Percentile Bootstrap) UCL	0.317
95% KM (z) UCL	0.315	95% KM Bootstrap t UCL	0.322
90% KM Chebyshev UCL	0.328	95% KM Chebyshev UCL	0.34
97.5% KM Chebyshev UCL	0.358	99% KM Chebyshev UCL	0.392

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.29	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.744	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.159	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.178	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	14.04	k star (bias corrected MLE)	12.31
Theta hat (MLE)	0.0265	Theta star (bias corrected MLE)	0.0303
nu hat (MLE)	673.8	nu star (bias corrected)	590.9
Mean (detects)	0.373		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.187
Maximum	0.724	Median	0.159
SD	0.15	CV	0.803
k hat (MLE)	1.164	k star (bias corrected MLE)	1.129
Theta hat (MLE)	0.161	Theta star (bias corrected MLE)	0.166
nu hat (MLE)	186.3	nu star (bias corrected)	180.6
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (180.63, α)	150.5	Adjusted Chi Square Value (180.63, β)	150
95% Gamma Approximate UCL (use when n>=50)	0.225	95% Gamma Adjusted UCL (use when n<50)	0.225

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.3	SD (KM)	0.0796
Variance (KM)	0.00634	SE of Mean (KM)	0.00925
k hat (KM)	14.19	k star (KM)	13.67
nu hat (KM)	2270	nu star (KM)	2186
theta hat (KM)	0.0211	theta star (KM)	0.0219
80% gamma percentile (KM)	0.365	90% gamma percentile (KM)	0.407
95% gamma percentile (KM)	0.445	99% gamma percentile (KM)	0.52

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	2079	Adjusted Chi Square Value (N/A, β)	2077
95% Gamma Approximate KM-UCL (use when n>=50)	0.315	95% Gamma Adjusted KM-UCL (use when n<50)	0.316

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.848	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.235	Mean in Log Scale	-1.552
SD in Original Scale	0.117	SD in Log Scale	0.452
95% t UCL (assumes normality of ROS data)	0.257	95% Percentile Bootstrap UCL	0.258
95% BCA Bootstrap UCL	0.259	95% Bootstrap t UCL	0.26
95% H-UCL (Log ROS)	0.257		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.228	KM Geo Mean	0.293
KM SD (logged)	0.199	95% Critical H Value (KM-Log)	1.708
KM Standard Error of Mean (logged)	0.0232	95% H-UCL (KM -Log)	0.31
KM SD (logged)	0.199	95% Critical H Value (KM-Log)	1.708
KM Standard Error of Mean (logged)	0.0232		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.22	Mean in Log Scale	-1.64
SD in Original Scale	0.127	SD in Log Scale	0.481
95% t UCL (Assumes normality)	0.244	95% H-Stat UCL	0.241

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.315	95% GROS Approximate Gamma UCL	0.225

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	78
		Number of Missing Observations	0
Minimum	0.178	Mean	2.136
Maximum	8.579	Median	1.546
SD	1.831	Std. Error of Mean	0.205
Coefficient of Variation	0.857	Skewness	1.61

Normal GOF Test

Shapiro Wilk Test Statistic	0.822	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	1.411E-13	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.477	95% Adjusted-CLT UCL (Chen-1995)	2.513
		95% Modified-t UCL (Johnson-1978)	2.483

Gamma GOF Test

A-D Test Statistic	0.69	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.769	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0911	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.101	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.61	k star (bias corrected MLE)	1.558
Theta hat (MLE)	1.327	Theta star (bias corrected MLE)	1.371
nu hat (MLE)	257.7	nu star (bias corrected)	249.3
MLE Mean (bias corrected)	2.136	MLE Sd (bias corrected)	1.711
		Approximate Chi Square Value (0.05)	213.8
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	213.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.492	95% Adjusted Gamma UCL (use when n<50)	2.499

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.31	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0654	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.728	Mean of logged Data	0.418
Maximum of Logged Data	2.149	SD of logged Data	0.863

Assuming Lognormal Distribution

95% H-UCL	2.713	90% Chebyshev (MVUE) UCL	2.919
95% Chebyshev (MVUE) UCL	3.249	97.5% Chebyshev (MVUE) UCL	3.708
99% Chebyshev (MVUE) UCL	4.608		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.473	95% Jackknife UCL	2.477
95% Standard Bootstrap UCL	2.478	95% Bootstrap-t UCL	2.512
95% Hall's Bootstrap UCL	2.519	95% Percentile Bootstrap UCL	2.489
95% BCA Bootstrap UCL	2.535		
90% Chebyshev(Mean, Sd) UCL	2.751	95% Chebyshev(Mean, Sd) UCL	3.029
97.5% Chebyshev(Mean, Sd) UCL	3.415	99% Chebyshev(Mean, Sd) UCL	4.173

Suggested UCL to Use

95% Approximate Gamma UCL	2.492

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	9
Number of Detects	16	Number of Non-Detects	64
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	0.01	Minimum Non-Detect	0.01
Maximum Detect	0.0203	Maximum Non-Detect	0.01
Variance Detects	9.6397E-6	Percent Non-Detects	80%
Mean Detects	0.0125	SD Detects	0.0031
Median Detects	0.0108	CV Detects	0.248
Skewness Detects	1.085	Kurtosis Detects	0.702
Mean of Logged Detects	-4.406	SD of Logged Detects	0.231

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.785	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.267	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0105	KM Standard Error of Mean	1.9417E-4
KM SD	0.00168	95% KM (BCA) UCL	0.0108
95% KM (t) UCL	0.0108	95% KM (Percentile Bootstrap) UCL	0.0108
95% KM (z) UCL	0.0108	95% KM Bootstrap t UCL	0.011
90% KM Chebyshev UCL	0.0111	95% KM Chebyshev UCL	0.0114
97.5% KM Chebyshev UCL	0.0117	99% KM Chebyshev UCL	0.0124

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.468	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.737	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.266	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.215	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	19.27	k star (bias corrected MLE)	15.7
Theta hat (MLE)	6.4986E-4	Theta star (bias corrected MLE)	7.9771E-4
nu hat (MLE)	616.7	nu star (bias corrected)	502.4
Mean (detects)	0.0125		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0105
Maximum	0.0203	Median	0.01
SD	0.00169	CV	0.161
k hat (MLE)	52.96	k star (bias corrected MLE)	50.98
Theta hat (MLE)	1.9837E-4	Theta star (bias corrected MLE)	2.0606E-4
nu hat (MLE)	8473	nu star (bias corrected)	8157
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (N/A, α)	7948	Adjusted Chi Square Value (N/A, β)	7944
95% Gamma Approximate UCL (use when n>=50)	0.0108	95% Gamma Adjusted UCL (use when n<50)	0.0108

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0105	SD (KM)	0.00168
Variance (KM)	2.8275E-6	SE of Mean (KM)	1.9417E-4
k hat (KM)	39.03	k star (KM)	37.57
nu hat (KM)	6245	nu star (KM)	6012
theta hat (KM)	2.6916E-4	theta star (KM)	2.7959E-4
80% gamma percentile (KM)	0.0119	90% gamma percentile (KM)	0.0128
95% gamma percentile (KM)	0.0135	99% gamma percentile (KM)	0.0149

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	5833	Adjusted Chi Square Value (N/A, β)	5829
95% Gamma Approximate KM-UCL (use when n>=50)	0.0108	95% Gamma Adjusted KM-UCL (use when n<50)	0.0108

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.797	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.255	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00664	Mean in Log Scale	-5.152
SD in Original Scale	0.00367	SD in Log Scale	0.528
95% t UCL (assumes normality of ROS data)	0.00732	95% Percentile Bootstrap UCL	0.00733
95% BCA Bootstrap UCL	0.00732	95% Bootstrap t UCL	0.00739
95% H-UCL (Log ROS)	0.00744		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.565	KM Geo Mean	0.0104
KM SD (logged)	0.128	95% Critical H Value (KM-Log)	1.685
KM Standard Error of Mean (logged)	0.0148	95% H-UCL (KM -Log)	0.0107
KM SD (logged)	0.128	95% Critical H Value (KM-Log)	1.685
KM Standard Error of Mean (logged)	0.0148		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00651	Mean in Log Scale	-5.12
SD in Original Scale	0.00332	SD in Log Scale	0.373
95% t UCL (Assumes normality)	0.00712	95% H-Stat UCL	0.00691

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0108	KM H-UCL	0.0107
95% KM (BCA) UCL	0.0108		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	69
Number of Detects	69	Number of Non-Detects	11
Number of Distinct Detects	69	Number of Distinct Non-Detects	1

Minimum Detect	0.03	Minimum Non-Detect	0.03
Maximum Detect	0.168	Maximum Non-Detect	0.03
Variance Detects	7.0675E-4	Percent Non-Detects	13.75%
Mean Detects	0.0653	SD Detects	0.0266
Median Detects	0.0626	CV Detects	0.407
Skewness Detects	1.325	Kurtosis Detects	2.452
Mean of Logged Detects	-2.802	SD of Logged Detects	0.38

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.902	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	9.8211E-6	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.11	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0604	KM Standard Error of Mean	0.00308
KM SD	0.0274	95% KM (BCA) UCL	0.0655
95% KM (t) UCL	0.0655	95% KM (Percentile Bootstrap) UCL	0.0656
95% KM (z) UCL	0.0655	95% KM Bootstrap t UCL	0.066
90% KM Chebyshev UCL	0.0697	95% KM Chebyshev UCL	0.0738
97.5% KM Chebyshev UCL	0.0797	99% KM Chebyshev UCL	0.0911

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.58	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.11	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.107	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.005	k star (bias corrected MLE)	6.71
Theta hat (MLE)	0.00932	Theta star (bias corrected MLE)	0.00973
nu hat (MLE)	966.7	nu star (bias corrected)	926
Mean (detects)	0.0653		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0588
Maximum	0.168	Median	0.0541
SD	0.0296	CV	0.504
k hat (MLE)	3.697	k star (bias corrected MLE)	3.567
Theta hat (MLE)	0.0159	Theta star (bias corrected MLE)	0.0165
nu hat (MLE)	591.5	nu star (bias corrected)	570.7
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (570.68, α)	516.3	Adjusted Chi Square Value (570.68, β)	515.3
95% Gamma Approximate UCL (use when n>=50)	0.065	95% Gamma Adjusted UCL (use when n<50)	0.0651

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0604	SD (KM)	0.0274
Variance (KM)	7.4819E-4	SE of Mean (KM)	0.00308
k hat (KM)	4.878	k star (KM)	4.703
nu hat (KM)	780.5	nu star (KM)	752.6
theta hat (KM)	0.0124	theta star (KM)	0.0128
80% gamma percentile (KM)	0.0818	90% gamma percentile (KM)	0.0977
95% gamma percentile (KM)	0.112	99% gamma percentile (KM)	0.143

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (752.55, α)	689.9	Adjusted Chi Square Value (752.55, β)	688.8
95% Gamma Approximate KM-UCL (use when n>=50)	0.0659	95% Gamma Adjusted KM-UCL (use when n<50)	0.066

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.972	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.33	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.102	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0598	Mean in Log Scale	-2.922
SD in Original Scale	0.0283	SD in Log Scale	0.468
95% t UCL (assumes normality of ROS data)	0.0651	95% Percentile Bootstrap UCL	0.0652
95% BCA Bootstrap UCL	0.0652	95% Bootstrap t UCL	0.0658
95% H-UCL (Log ROS)	0.0661		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.899	KM Geo Mean	0.0551
KM SD (logged)	0.426	95% Critical H Value (KM-Log)	1.815
KM Standard Error of Mean (logged)	0.048	95% H-UCL (KM -Log)	0.0658
KM SD (logged)	0.426	95% Critical H Value (KM-Log)	1.815
KM Standard Error of Mean (logged)	0.048		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0584	Mean in Log Scale	-2.995
SD in Original Scale	0.0302	SD in Log Scale	0.599
95% t UCL (Assumes normality)	0.064	95% H-Stat UCL	0.0682

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.0659	95% GROS Approximate Gamma UCL	0.065

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	65
Number of Detects	62	Number of Non-Detects	18
Number of Distinct Detects	62	Number of Distinct Non-Detects	3
Minimum Detect	0.0626	Minimum Non-Detect	0.06
Maximum Detect	1.07	Maximum Non-Detect	0.541
Variance Detects	0.0922	Percent Non-Detects	22.5%
Mean Detects	0.381	SD Detects	0.304
Median Detects	0.416	CV Detects	0.798
Skewness Detects	0.419	Kurtosis Detects	-1.146
Mean of Logged Detects	-1.4	SD of Logged Detects	1.011

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.836	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	3.9977E-9	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.255	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.31	KM Standard Error of Mean	0.0335
KM SD	0.297	95% KM (BCA) UCL	0.366
95% KM (t) UCL	0.366	95% KM (Percentile Bootstrap) UCL	0.363
95% KM (z) UCL	0.365	95% KM Bootstrap t UCL	0.368
90% KM Chebyshev UCL	0.41	95% KM Chebyshev UCL	0.456
97.5% KM Chebyshev UCL	0.519	99% KM Chebyshev UCL	0.643

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.25	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.773	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.21	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.116	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.294	k star (bias corrected MLE)	1.242
Theta hat (MLE)	0.294	Theta star (bias corrected MLE)	0.306
nu hat (MLE)	160.5	nu star (bias corrected)	154.1
Mean (detects)	0.381		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.302
Maximum	1.07	Median	0.117
SD	0.305	CV	1.01
k hat (MLE)	0.781	k star (bias corrected MLE)	0.76
Theta hat (MLE)	0.387	Theta star (bias corrected MLE)	0.397
nu hat (MLE)	124.9	nu star (bias corrected)	121.6
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (121.59, α)	97.13	Adjusted Chi Square Value (121.59, β)	96.73
95% Gamma Approximate UCL (use when n>=50)	0.378	95% Gamma Adjusted UCL (use when n<50)	0.38

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.31	SD (KM)	0.297
Variance (KM)	0.0879	SE of Mean (KM)	0.0335
k hat (KM)	1.093	k star (KM)	1.06
nu hat (KM)	174.8	nu star (KM)	169.6
theta hat (KM)	0.284	theta star (KM)	0.292
80% gamma percentile (KM)	0.496	90% gamma percentile (KM)	0.704
95% gamma percentile (KM)	0.91	99% gamma percentile (KM)	1.386

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (169.62, α)	140.5	Adjusted Chi Square Value (169.62, β)	140
95% Gamma Approximate KM-UCL (use when n>=50)	0.374	95% Gamma Adjusted KM-UCL (use when n<50)	0.375

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.818	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	3.855E-10	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.225	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.303	Mean in Log Scale	-1.86
SD in Original Scale	0.303	SD in Log Scale	1.268
95% t UCL (assumes normality of ROS data)	0.36	95% Percentile Bootstrap UCL	0.356
95% BCA Bootstrap UCL	0.36	95% Bootstrap t UCL	0.364
95% H-UCL (Log ROS)	0.5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.707	KM Geo Mean	0.181
KM SD (logged)	1.057	95% Critical H Value (KM-Log)	2.325
KM Standard Error of Mean (logged)	0.12	95% H-UCL (KM -Log)	0.418
KM SD (logged)	1.057	95% Critical H Value (KM-Log)	2.325
KM Standard Error of Mean (logged)	0.12		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.308	Mean in Log Scale	-1.819
SD in Original Scale	0.302	SD in Log Scale	1.229
95% t UCL (Assumes normality)	0.364	95% H-Stat UCL	0.487

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use
95% KM (Chebyshev) UCL 0.456

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	54
Number of Detects	51	Number of Non-Detects	29
Number of Distinct Detects	45	Number of Distinct Non-Detects	10
Minimum Detect	0.0323	Minimum Non-Detect	0.03
Maximum Detect	0.0952	Maximum Non-Detect	0.04
Variance Detects	1.9159E-4	Percent Non-Detects	36.25%
Mean Detects	0.0505	SD Detects	0.0138
Median Detects	0.0453	CV Detects	0.274
Skewness Detects	1.498	Kurtosis Detects	2.128
Mean of Logged Detects	-3.017	SD of Logged Detects	0.245

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.854	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	1.5907E-6	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.171	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.123	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0438	KM Standard Error of Mean	0.00163
KM SD	0.0142	95% KM (BCA) UCL	0.0465
95% KM (t) UCL	0.0465	95% KM (Percentile Bootstrap) UCL	0.0465
95% KM (z) UCL	0.0465	95% KM Bootstrap t UCL	0.0469
90% KM Chebyshev UCL	0.0487	95% KM Chebyshev UCL	0.0509
97.5% KM Chebyshev UCL	0.054	99% KM Chebyshev UCL	0.06

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.591	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.749	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.158	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.124	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	16.06	k star (bias corrected MLE)	15.13
Theta hat (MLE)	0.00314	Theta star (bias corrected MLE)	0.00334
nu hat (MLE)	1639	nu star (bias corrected)	1544
Mean (detects)	0.0505		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0408
Maximum	0.0952	Median	0.0401
SD	0.0174	CV	0.426
k hat (MLE)	5.467	k star (bias corrected MLE)	5.27
Theta hat (MLE)	0.00747	Theta star (bias corrected MLE)	0.00775
nu hat (MLE)	874.7	nu star (bias corrected)	843.2
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (843.22, α)	776.8	Adjusted Chi Square Value (843.22, β)	775.7
95% Gamma Approximate UCL (use when n>=50)	0.0443	95% Gamma Adjusted UCL (use when n<50)	0.0444

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0438	SD (KM)	0.0142
Variance (KM)	2.0058E-4	SE of Mean (KM)	0.00163
k hat (KM)	9.567	k star (KM)	9.216
nu hat (KM)	1531	nu star (KM)	1475
theta hat (KM)	0.00458	theta star (KM)	0.00475
80% gamma percentile (KM)	0.0553	90% gamma percentile (KM)	0.063
95% gamma percentile (KM)	0.0699	99% gamma percentile (KM)	0.0841

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1386	Adjusted Chi Square Value (N/A, β)	1385
95% Gamma Approximate KM-UCL (use when n>=50)	0.0466	95% Gamma Adjusted KM-UCL (use when n<50)	0.0466

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.928	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0.00509	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.147	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.123	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0426	Mean in Log Scale	-3.216
SD in Original Scale	0.0155	SD in Log Scale	0.342
95% t UCL (assumes normality of ROS data)	0.0455	95% Percentile Bootstrap UCL	0.0455
95% BCA Bootstrap UCL	0.0456	95% Bootstrap t UCL	0.0458
95% H-UCL (Log ROS)	0.0455		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.172	KM Geo Mean	0.0419
KM SD (logged)	0.285	95% Critical H Value (KM-Log)	1.743
KM Standard Error of Mean (logged)	0.0335	95% H-UCL (KM -Log)	0.0462
KM SD (logged)	0.285	95% Critical H Value (KM-Log)	1.743
KM Standard Error of Mean (logged)	0.0335		

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0391	Mean in Log Scale	-3.362
SD in Original Scale	0.0188	SD in Log Scale	0.502
95% t UCL (Assumes normality)	0.0426	95% H-Stat UCL	0.0437

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0465	KM H-UCL	0.0462
95% KM (BCA) UCL	0.0465		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	79
Number of Detects	59	Number of Non-Detects	21
Number of Distinct Detects	59	Number of Distinct Non-Detects	21
Minimum Detect	0.212	Minimum Non-Detect	0.224
Maximum Detect	1.531	Maximum Non-Detect	0.59
Variance Detects	0.0688	Percent Non-Detects	26.25%
Mean Detects	0.58	SD Detects	0.262
Median Detects	0.524	CV Detects	0.452
Skewness Detects	1.498	Kurtosis Detects	2.847
Mean of Logged Detects	-0.633	SD of Logged Detects	0.418

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.885	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	7.0178E-6	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.141	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.115	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.502	KM Standard Error of Mean	0.03
KM SD	0.262	95% KM (BCA) UCL	0.556
95% KM (t) UCL	0.552	95% KM (Percentile Bootstrap) UCL	0.555
95% KM (z) UCL	0.552	95% KM Bootstrap t UCL	0.557
90% KM Chebyshev UCL	0.592	95% KM Chebyshev UCL	0.633
97.5% KM Chebyshev UCL	0.69	99% KM Chebyshev UCL	0.801

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.486	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0839	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.116	Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.846	k star (bias corrected MLE)	5.56
Theta hat (MLE)	0.0992	Theta star (bias corrected MLE)	0.104
nu hat (MLE)	689.8	nu star (bias corrected)	656.1
Mean (detects)	0.58		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.131	Mean	0.49
Maximum	1.531	Median	0.447
SD	0.273	CV	0.557
k hat (MLE)	3.633	k star (bias corrected MLE)	3.505
Theta hat (MLE)	0.135	Theta star (bias corrected MLE)	0.14
nu hat (MLE)	581.3	nu star (bias corrected)	560.8
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (560.83, α)	506.9	Adjusted Chi Square Value (560.83, β)	506
95% Gamma Approximate UCL (use when n>=50)	0.543	95% Gamma Adjusted UCL (use when n<50)	0.544

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.502	SD (KM)	0.262
Variance (KM)	0.0688	SE of Mean (KM)	0.03
k hat (KM)	3.67	k star (KM)	3.541
nu hat (KM)	587.2	nu star (KM)	566.5
theta hat (KM)	0.137	theta star (KM)	0.142
80% gamma percentile (KM)	0.703	90% gamma percentile (KM)	0.86
95% gamma percentile (KM)	1.006	99% gamma percentile (KM)	1.32

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (566.54, α)	512.3	Adjusted Chi Square Value (566.54, β)	511.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.556	95% Gamma Adjusted KM-UCL (use when n<50)	0.557

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.984	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.828	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0671	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.503	Mean in Log Scale	-0.798
SD in Original Scale	0.261	SD in Log Scale	0.462
95% t UCL (assumes normality of ROS data)	0.552	95% Percentile Bootstrap UCL	0.554
95% BCA Bootstrap UCL	0.557	95% Bootstrap t UCL	0.558
95% H-UCL (Log ROS)	0.551		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.808	KM Geo Mean	0.446
KM SD (logged)	0.483	95% Critical H Value (KM-Log)	1.849
KM Standard Error of Mean (logged)	0.0568	95% H-UCL (KM -Log)	0.554
KM SD (logged)	0.483	95% Critical H Value (KM-Log)	1.849
KM Standard Error of Mean (logged)	0.0568		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.48	Mean in Log Scale	-0.901
SD in Original Scale	0.282	SD in Log Scale	0.596
95% t UCL (Assumes normality)	0.533	95% H-Stat UCL	0.552

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.556	95% GROS Approximate Gamma UCL	0.543

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	78
		Number of Missing Observations	0
Minimum	3.983	Mean	9.936
Maximum	27.24	Median	8.77
SD	4.749	Std. Error of Mean	0.531
Coefficient of Variation	0.478	Skewness	1.889

Normal GOF Test

Shapiro Wilk Test Statistic	0.81	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.332E-14	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.177	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	10.82	95% Adjusted-CLT UCL (Chen-1995)	10.93
		95% Modified-t UCL (Johnson-1978)	10.84

Gamma GOF Test

A-D Test Statistic	1.693	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.116	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0999	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	5.847	k star (bias corrected MLE)	5.636
Theta hat (MLE)	1.699	Theta star (bias corrected MLE)	1.763
nu hat (MLE)	935.5	nu star (bias corrected)	901.8
MLE Mean (bias corrected)	9.936	MLE Sd (bias corrected)	4.185
		Approximate Chi Square Value (0.05)	833.1
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	831.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	10.76	95% Adjusted Gamma UCL (use when n<50)	10.77

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0223	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0883	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.382	Mean of logged Data	2.208
Maximum of Logged Data	3.305	SD of logged Data	0.404

Assuming Lognormal Distribution

95% H-UCL	10.71	90% Chebyshev (MVUE) UCL	11.24
95% Chebyshev (MVUE) UCL	11.87	97.5% Chebyshev (MVUE) UCL	12.74
99% Chebyshev (MVUE) UCL	14.45		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	10.81	95% Jackknife UCL	10.82
95% Standard Bootstrap UCL	10.81	95% Bootstrap-t UCL	10.95
95% Hall's Bootstrap UCL	10.93	95% Percentile Bootstrap UCL	10.84
95% BCA Bootstrap UCL	11.03		
90% Chebyshev(Mean, Sd) UCL	11.53	95% Chebyshev(Mean, Sd) UCL	12.25
97.5% Chebyshev(Mean, Sd) UCL	13.25	99% Chebyshev(Mean, Sd) UCL	15.22

Suggested UCL to Use

95% Student's-t UCL	10.82	or 95% Modified-t UCL	10.84
or 95% H-UCL	10.71		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lead (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	66
Number of Detects	48	Number of Non-Detects	32
Number of Distinct Detects	48	Number of Distinct Non-Detects	19
Minimum Detect	0.24	Minimum Non-Detect	0.23
Maximum Detect	2.859	Maximum Non-Detect	0.331
Variance Detects	0.253	Percent Non-Detects	40%
Mean Detects	0.528	SD Detects	0.503
Median Detects	0.38	CV Detects	0.953
Skewness Detects	3.337	Kurtosis Detects	11.62
Mean of Logged Detects	-0.849	SD of Logged Detects	0.552

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.535	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.342	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.409	KM Standard Error of Mean	0.0465
KM SD	0.412	95% KM (BCA) UCL	0.5
95% KM (t) UCL	0.486	95% KM (Percentile Bootstrap) UCL	0.495
95% KM (z) UCL	0.485	95% KM Bootstrap t UCL	0.531
90% KM Chebyshev UCL	0.548	95% KM Chebyshev UCL	0.612
97.5% KM Chebyshev UCL	0.699	99% KM Chebyshev UCL	0.872

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.932	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.759	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.263	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.129	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.538	k star (bias corrected MLE)	2.394
Theta hat (MLE)	0.208	Theta star (bias corrected MLE)	0.22
nu hat (MLE)	243.7	nu star (bias corrected)	229.8
Mean (detects)	0.528		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.321
Maximum	2.859	Median	0.287
SD	0.464	CV	1.448
k hat (MLE)	0.52	k star (bias corrected MLE)	0.509
Theta hat (MLE)	0.616	Theta star (bias corrected MLE)	0.63
nu hat (MLE)	83.22	nu star (bias corrected)	81.43
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (81.43, α)	61.64	Adjusted Chi Square Value (81.43, β)	61.32
95% Gamma Approximate UCL (use when n>=50)	0.423	95% Gamma Adjusted UCL (use when n<50)	0.426

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.409	SD (KM)	0.412
Variance (KM)	0.17	SE of Mean (KM)	0.0465
k hat (KM)	0.986	k star (KM)	0.957
nu hat (KM)	157.7	nu star (KM)	153.1
theta hat (KM)	0.415	theta star (KM)	0.427
80% gamma percentile (KM)	0.66	90% gamma percentile (KM)	0.952
95% gamma percentile (KM)	1.244	99% gamma percentile (KM)	1.925

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (153.14, α)	125.5	Adjusted Chi Square Value (153.14, β)	125.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.499	95% Gamma Adjusted KM-UCL (use when n<50)	0.501

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.79	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.367	Mean in Log Scale	-1.35
SD in Original Scale	0.436	SD in Log Scale	0.768
95% t UCL (assumes normality of ROS data)	0.448	95% Percentile Bootstrap UCL	0.453
95% BCA Bootstrap UCL	0.472	95% Bootstrap t UCL	0.506
95% H-UCL (Log ROS)	0.415		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.096	KM Geo Mean	0.334
KM SD (logged)	0.52	95% Critical H Value (KM-Log)	1.872
KM Standard Error of Mean (logged)	0.0588	95% H-UCL (KM -Log)	0.427
KM SD (logged)	0.52	95% Critical H Value (KM-Log)	1.872
KM Standard Error of Mean (logged)	0.0588		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.365	Mean in Log Scale	-1.358
SD in Original Scale	0.437	SD in Log Scale	0.759
95% t UCL (Assumes normality)	0.446	95% H-Stat UCL	0.408

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.612

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	80
		Number of Missing Observations	0
Minimum	0.788	Mean	7.126
Maximum	46.32	Median	5.413
SD	7.177	Std. Error of Mean	0.802
Coefficient of Variation	1.007	Skewness	3.335

Normal GOF Test

Shapiro Wilk Test Statistic	0.682	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8.462	95% Adjusted-CLT UCL (Chen-1995)	8.766
		95% Modified-t UCL (Johnson-1978)	8.512

Gamma GOF Test

A-D Test Statistic	0.764	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.768	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0844	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.101	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.64	k star (bias corrected MLE)	1.587
Theta hat (MLE)	4.346	Theta star (bias corrected MLE)	4.491
nu hat (MLE)	262.4	nu star (bias corrected)	253.9
MLE Mean (bias corrected)	7.126	MLE Sd (bias corrected)	5.657
		Approximate Chi Square Value (0.05)	218
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	217.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	8.3	95% Adjusted Gamma UCL (use when n<50)	8.323

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.981	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.636	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0642	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.238	Mean of logged Data	1.629
Maximum of Logged Data	3.836	SD of logged Data	0.819

Assuming Lognormal Distribution

95% H-UCL	8.651	90% Chebyshev (MVUE) UCL	9.302
95% Chebyshev (MVUE) UCL	10.3	97.5% Chebyshev (MVUE) UCL	11.69
99% Chebyshev (MVUE) UCL	14.43		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8.446	95% Jackknife UCL	8.462
95% Standard Bootstrap UCL	8.449	95% Bootstrap-t UCL	8.98
95% Hall's Bootstrap UCL	9.293	95% Percentile Bootstrap UCL	8.433
95% BCA Bootstrap UCL	8.948		
90% Chebyshev(Mean, Sd) UCL	9.533	95% Chebyshev(Mean, Sd) UCL	10.62
97.5% Chebyshev(Mean, Sd) UCL	12.14	99% Chebyshev(Mean, Sd) UCL	15.11

Suggested UCL to Use

95% Approximate Gamma UCL 8.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	80
		Number of Missing Observations	0
Minimum	0.00704	Mean	0.0364
Maximum	0.138	Median	0.0288
SD	0.0259	Std. Error of Mean	0.0029
Coefficient of Variation	0.712	Skewness	1.594

Normal GOF Test

Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	8.526E-12	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0413	95% Adjusted-CLT UCL (Chen-1995)	0.0418
		95% Modified-t UCL (Johnson-1978)	0.0414

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	0.935	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.761	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0901	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.101	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.464	k star (bias corrected MLE)	2.38
Theta hat (MLE)	0.0148	Theta star (bias corrected MLE)	0.0153
nu hat (MLE)	394.3	nu star (bias corrected)	380.9
MLE Mean (bias corrected)	0.0364	MLE Sd (bias corrected)	0.0236
		Approximate Chi Square Value (0.05)	336.6
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	335.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	0.0412	95% Adjusted Gamma UCL (use when n<50)	0.0413

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.434	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0622	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0991	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.956	Mean of logged Data	-3.528
Maximum of Logged Data	-1.979	SD of logged Data	0.657

Assuming Lognormal Distribution

95% H-UCL	0.0421	90% Chebyshev (MVUE) UCL	0.045
95% Chebyshev (MVUE) UCL	0.049	97.5% Chebyshev (MVUE) UCL	0.0545
99% Chebyshev (MVUE) UCL	0.0652		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0412	95% Jackknife UCL	0.0413
95% Standard Bootstrap UCL	0.0412	95% Bootstrap-t UCL	0.0415
95% Hall's Bootstrap UCL	0.042	95% Percentile Bootstrap UCL	0.0413
95% BCA Bootstrap UCL	0.0419		
90% Chebyshev(Mean, Sd) UCL	0.0451	95% Chebyshev(Mean, Sd) UCL	0.0491
97.5% Chebyshev(Mean, Sd) UCL	0.0545	99% Chebyshev(Mean, Sd) UCL	0.0653

Suggested UCL to Use

95% Approximate Gamma UCL	0.0412

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	48
Number of Detects	49	Number of Non-Detects	31
Number of Distinct Detects	48	Number of Distinct Non-Detects	1
Minimum Detect	0.07	Minimum Non-Detect	0.07
Maximum Detect	0.256	Maximum Non-Detect	0.07
Variance Detects	0.00133	Percent Non-Detects	38.75%
Mean Detects	0.0953	SD Detects	0.0365
Median Detects	0.0849	CV Detects	0.383
Skewness Detects	3.514	Kurtosis Detects	13.51
Mean of Logged Detects	-2.395	SD of Logged Detects	0.269

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.572	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.253	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.126	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0855	KM Standard Error of Mean	0.00349
KM SD	0.0309	95% KM (BCA) UCL	0.0924
95% KM (t) UCL	0.0913	95% KM (Percentile Bootstrap) UCL	0.0916
95% KM (z) UCL	0.0912	95% KM Bootstrap t UCL	0.0952
90% KM Chebyshev UCL	0.0959	95% KM Chebyshev UCL	0.101
97.5% KM Chebyshev UCL	0.107	99% KM Chebyshev UCL	0.12

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.193	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.749	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.241	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.126	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	11.45	k star (bias corrected MLE)	10.76
Theta hat (MLE)	0.00832	Theta star (bias corrected MLE)	0.00885
nu hat (MLE)	1122	nu star (bias corrected)	1055
Mean (detects)	0.0953		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0705
Maximum	0.256	Median	0.0747
SD	0.0432	CV	0.613
k hat (MLE)	2.556	k star (bias corrected MLE)	2.468
Theta hat (MLE)	0.0276	Theta star (bias corrected MLE)	0.0286
nu hat (MLE)	408.9	nu star (bias corrected)	394.9
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (394.93, α)	349.9	Adjusted Chi Square Value (394.93, β)	349.1
95% Gamma Approximate UCL (use when n>=50)	0.0796	95% Gamma Adjusted UCL (use when n<50)	0.0798

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0855	SD (KM)	0.0309
Variance (KM)	9.5197E-4	SE of Mean (KM)	0.00349
k hat (KM)	7.674	k star (KM)	7.394
nu hat (KM)	1228	nu star (KM)	1183
theta hat (KM)	0.0111	theta star (KM)	0.0116
80% gamma percentile (KM)	0.11	90% gamma percentile (KM)	0.127
95% gamma percentile (KM)	0.143	99% gamma percentile (KM)	0.175

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1104	Adjusted Chi Square Value (N/A, β)	1103
95% Gamma Approximate KM-UCL (use when n>=50)	0.0916	95% Gamma Adjusted KM-UCL (use when n<50)	0.0917

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.745	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.227	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.126	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0775	Mean in Log Scale	-2.639
SD in Original Scale	0.0367	SD in Log Scale	0.393
95% t UCL (assumes normality of ROS data)	0.0844	95% Percentile Bootstrap UCL	0.0848
95% BCA Bootstrap UCL	0.0854	95% Bootstrap t UCL	0.0868
95% H-UCL (Log ROS)	0.0835		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.498	KM Geo Mean	0.0823
KM SD (logged)	0.245	95% Critical H Value (KM-Log)	1.726
KM Standard Error of Mean (logged)	0.0277	95% H-UCL (KM -Log)	0.0889
KM SD (logged)	0.245	95% Critical H Value (KM-Log)	1.726
KM Standard Error of Mean (logged)	0.0277		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0719	Mean in Log Scale	-2.766
SD in Original Scale	0.041	SD in Log Scale	0.514
95% t UCL (Assumes normality)	0.0795	95% H-Stat UCL	0.08

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0913	KM H-UCL	0.0889
95% KM (BCA) UCL	0.0924		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	59
Number of Detects	22	Number of Non-Detects	58
Number of Distinct Detects	22	Number of Distinct Non-Detects	38
Minimum Detect	0.734	Minimum Non-Detect	0.713
Maximum Detect	1.666	Maximum Non-Detect	1.019
Variance Detects	0.0491	Percent Non-Detects	72.5%
Mean Detects	0.955	SD Detects	0.221
Median Detects	0.905	CV Detects	0.232
Skewness Detects	1.85	Kurtosis Detects	4.272
Mean of Logged Detects	-0.0672	SD of Logged Detects	0.205

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.193	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.78	KM Standard Error of Mean	0.018
KM SD	0.157	95% KM (BCA) UCL	0.815
95% KM (t) UCL	0.81	95% KM (Percentile Bootstrap) UCL	0.812
95% KM (z) UCL	0.81	95% KM Bootstrap t UCL	0.821
90% KM Chebyshev UCL	0.834	95% KM Chebyshev UCL	0.859
97.5% KM Chebyshev UCL	0.893	99% KM Chebyshev UCL	0.959

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.714	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.156	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.185	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	23.27	k star (bias corrected MLE)	20.13
Theta hat (MLE)	0.0411	Theta star (bias corrected MLE)	0.0475
nu hat (MLE)	1024	nu star (bias corrected)	885.7
Mean (detects)	0.955		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.499
Maximum	1.666	Median	0.334
SD	0.32	CV	0.642
k hat (MLE)	2.287	k star (bias corrected MLE)	2.209
Theta hat (MLE)	0.218	Theta star (bias corrected MLE)	0.226
nu hat (MLE)	365.9	nu star (bias corrected)	353.5
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (353.51, α)	310.9	Adjusted Chi Square Value (353.51, β)	310.2
95% Gamma Approximate UCL (use when n>=50)	0.568	95% Gamma Adjusted UCL (use when n<50)	0.569

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.78	SD (KM)	0.157
Variance (KM)	0.0246	SE of Mean (KM)	0.018
k hat (KM)	24.81	k star (KM)	23.89
nu hat (KM)	3969	nu star (KM)	3822
theta hat (KM)	0.0315	theta star (KM)	0.0327
80% gamma percentile (KM)	0.911	90% gamma percentile (KM)	0.991
95% gamma percentile (KM)	1.06	99% gamma percentile (KM)	1.199

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	3679	Adjusted Chi Square Value (N/A, β)	3677
95% Gamma Approximate KM-UCL (use when n>=50)	0.811	95% Gamma Adjusted KM-UCL (use when n<50)	0.811

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.145	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.613	Mean in Log Scale	-0.553
SD in Original Scale	0.248	SD in Log Scale	0.342
95% t UCL (assumes normality of ROS data)	0.659	95% Percentile Bootstrap UCL	0.66
95% BCA Bootstrap UCL	0.666	95% Bootstrap t UCL	0.666
95% H-UCL (Log ROS)	0.653		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.263	KM Geo Mean	0.769
KM SD (logged)	0.16	95% Critical H Value (KM-Log)	1.695
KM Standard Error of Mean (logged)	0.0184	95% H-UCL (KM -Log)	0.803
KM SD (logged)	0.16	95% Critical H Value (KM-Log)	1.695
KM Standard Error of Mean (logged)	0.0184		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.53	Mean in Log Scale	-0.743
SD in Original Scale	0.288	SD in Log Scale	0.433
95% t UCL (Assumes normality)	0.584	95% H-Stat UCL	0.571

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.811	95% GROS Approximate Gamma UCL	0.568

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	72
Number of Detects	71	Number of Non-Detects	9
Number of Distinct Detects	71	Number of Distinct Non-Detects	1
Minimum Detect	0.152	Minimum Non-Detect	0.15
Maximum Detect	0.587	Maximum Non-Detect	0.15
Variance Detects	0.0122	Percent Non-Detects	11.25%
Mean Detects	0.253	SD Detects	0.11
Median Detects	0.209	CV Detects	0.436
Skewness Detects	1.516	Kurtosis Detects	1.393
Mean of Logged Detects	-1.449	SD of Logged Detects	0.369

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.78	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	1.554E-14	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.105	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.241	KM Standard Error of Mean	0.0122
KM SD	0.108	95% KM (BCA) UCL	0.261
95% KM (t) UCL	0.262	95% KM (Percentile Bootstrap) UCL	0.262
95% KM (z) UCL	0.261	95% KM Bootstrap t UCL	0.265
90% KM Chebyshev UCL	0.278	95% KM Chebyshev UCL	0.295
97.5% KM Chebyshev UCL	0.318	99% KM Chebyshev UCL	0.363

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.769	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.189	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.106	Detected Data Not Gamma Distributed at 5% Significance Level	

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.861	k star (bias corrected MLE)	6.58
Theta hat (MLE)	0.0369	Theta star (bias corrected MLE)	0.0384
nu hat (MLE)	974.3	nu star (bias corrected)	934.4
Mean (detects)	0.253		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0204	Mean	0.232
Maximum	0.587	Median	0.202
SD	0.121	CV	0.521
k hat (MLE)	3.597	k star (bias corrected MLE)	3.47
Theta hat (MLE)	0.0644	Theta star (bias corrected MLE)	0.0667
nu hat (MLE)	575.5	nu star (bias corrected)	555.3
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (555.28, α)	501.6	Adjusted Chi Square Value (555.28, β)	500.7
95% Gamma Approximate UCL (use when n>=50)	0.256	95% Gamma Adjusted UCL (use when n<50)	0.257

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.241	SD (KM)	0.108
Variance (KM)	0.0117	SE of Mean (KM)	0.0122
k hat (KM)	4.978	k star (KM)	4.8
nu hat (KM)	796.5	nu star (KM)	767.9
theta hat (KM)	0.0485	theta star (KM)	0.0503
80% gamma percentile (KM)	0.326	90% gamma percentile (KM)	0.389
95% gamma percentile (KM)	0.446	99% gamma percentile (KM)	0.568

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (767.94, α)	704.6	Adjusted Chi Square Value (767.94, β)	703.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.263	95% Gamma Adjusted KM-UCL (use when n<50)	0.264

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.864	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	1.1932E-8	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.165	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.105	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.236	Mean in Log Scale	-1.542
SD in Original Scale	0.114	SD in Log Scale	0.439
95% t UCL (assumes normality of ROS data)	0.257	95% Percentile Bootstrap UCL	0.258
95% BCA Bootstrap UCL	0.259	95% Bootstrap t UCL	0.259
95% H-UCL (Log ROS)	0.258		

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.499	KM Geo Mean	0.223
KM SD (logged)	0.373	95% Critical H Value (KM-Log)	1.786
KM Standard Error of Mean (logged)	0.042	95% H-UCL (KM -Log)	0.258
KM SD (logged)	0.373	95% Critical H Value (KM-Log)	1.786
KM Standard Error of Mean (logged)	0.042		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.233	Mean in Log Scale	-1.577
SD in Original Scale	0.118	SD in Log Scale	0.502
95% t UCL (Assumes normality)	0.255	95% H-Stat UCL	0.26

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.262	KM H-UCL	0.258
95% KM (BCA) UCL	0.261		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	41
Number of Detects	28	Number of Non-Detects	52
Number of Distinct Detects	28	Number of Distinct Non-Detects	13
Minimum Detect	0.313	Minimum Non-Detect	0.302
Maximum Detect	1.011	Maximum Non-Detect	0.431
Variance Detects	0.0283	Percent Non-Detects	65%
Mean Detects	0.471	SD Detects	0.168
Median Detects	0.424	CV Detects	0.357
Skewness Detects	1.484	Kurtosis Detects	2.58
Mean of Logged Detects	-0.804	SD of Logged Detects	0.318

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.846	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.361	KM Standard Error of Mean	0.0144
KM SD	0.127	95% KM (BCA) UCL	0.388
95% KM (t) UCL	0.385	95% KM (Percentile Bootstrap) UCL	0.387
95% KM (z) UCL	0.385	95% KM Bootstrap t UCL	0.39
90% KM Chebyshev UCL	0.405	95% KM Chebyshev UCL	0.424
97.5% KM Chebyshev UCL	0.451	99% KM Chebyshev UCL	0.505

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.9	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.745	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.165	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	9.742	k star (bias corrected MLE)	8.722
Theta hat (MLE)	0.0484	Theta star (bias corrected MLE)	0.054
nu hat (MLE)	545.6	nu star (bias corrected)	488.4
Mean (detects)	0.471		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.215
Maximum	1.011	Median	0.124
SD	0.221	CV	1.03
k hat (MLE)	0.754	k star (bias corrected MLE)	0.734
Theta hat (MLE)	0.285	Theta star (bias corrected MLE)	0.293
nu hat (MLE)	120.6	nu star (bias corrected)	117.4
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (117.44, α)	93.42	Adjusted Chi Square Value (117.44, β)	93.03
95% Gamma Approximate UCL (use when n>=50)	0.27	95% Gamma Adjusted UCL (use when n<50)	0.271

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.361	SD (KM)	0.127
Variance (KM)	0.0161	SE of Mean (KM)	0.0144
k hat (KM)	8.104	k star (KM)	7.809
nu hat (KM)	1297	nu star (KM)	1249
theta hat (KM)	0.0446	theta star (KM)	0.0463
80% gamma percentile (KM)	0.463	90% gamma percentile (KM)	0.534
95% gamma percentile (KM)	0.597	99% gamma percentile (KM)	0.728

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1168	Adjusted Chi Square Value (N/A, β)	1167
95% Gamma Approximate KM-UCL (use when n>=50)	0.386	95% Gamma Adjusted KM-UCL (use when n<50)	0.387

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.279	Mean in Log Scale	-1.448
SD in Original Scale	0.178	SD in Log Scale	0.58
95% t UCL (assumes normality of ROS data)	0.312	95% Percentile Bootstrap UCL	0.315
95% BCA Bootstrap UCL	0.317	95% Bootstrap t UCL	0.318
95% H-UCL (Log ROS)	0.315		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.06	KM Geo Mean	0.346
KM SD (logged)	0.264	95% Critical H Value (KM-Log)	1.733
KM Standard Error of Mean (logged)	0.03	95% H-UCL (KM -Log)	0.378
KM SD (logged)	0.264	95% Critical H Value (KM-Log)	1.733
KM Standard Error of Mean (logged)	0.03		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.266	Mean in Log Scale	-1.492
SD in Original Scale	0.181	SD in Log Scale	0.542
95% t UCL (Assumes normality)	0.3	95% H-Stat UCL	0.292

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.386	95% GROS Approximate Gamma UCL	0.27

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	32
Number of Detects	30	Number of Non-Detects	50
Number of Distinct Detects	30	Number of Distinct Non-Detects	2

Minimum Detect	0.142	Minimum Non-Detect	0.14
Maximum Detect	0.626	Maximum Non-Detect	0.2
Variance Detects	0.0102	Percent Non-Detects	62.5%
Mean Detects	0.203	SD Detects	0.101
Median Detects	0.159	CV Detects	0.498
Skewness Detects	2.968	Kurtosis Detects	10.33
Mean of Logged Detects	-1.669	SD of Logged Detects	0.355

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.619	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.164	KM Standard Error of Mean	0.00775
KM SD	0.0681	95% KM (BCA) UCL	0.179
95% KM (t) UCL	0.177	95% KM (Percentile Bootstrap) UCL	0.177
95% KM (z) UCL	0.177	95% KM Bootstrap t UCL	0.186
90% KM Chebyshev UCL	0.187	95% KM Chebyshev UCL	0.198
97.5% KM Chebyshev UCL	0.212	99% KM Chebyshev UCL	0.241

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.095	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.288	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.16	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.812	k star (bias corrected MLE)	6.153
Theta hat (MLE)	0.0298	Theta star (bias corrected MLE)	0.033
nu hat (MLE)	408.7	nu star (bias corrected)	369.2
Mean (detects)	0.203		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0922
Maximum	0.626	Median	0.0475
SD	0.108	CV	1.167
k hat (MLE)	0.789	k star (bias corrected MLE)	0.768
Theta hat (MLE)	0.117	Theta star (bias corrected MLE)	0.12
nu hat (MLE)	126.3	nu star (bias corrected)	122.8
Adjusted Level of Significance (β)	0.047		
Approximate Chi Square Value (122.85, α)	98.25	Adjusted Chi Square Value (122.85, β)	97.85
95% Gamma Approximate UCL (use when n>=50)	0.115	95% Gamma Adjusted UCL (use when n<50)	0.116

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.164	SD (KM)	0.0681
Variance (KM)	0.00464	SE of Mean (KM)	0.00775
k hat (KM)	5.777	k star (KM)	5.569
nu hat (KM)	924.4	nu star (KM)	891.1
theta hat (KM)	0.0283	theta star (KM)	0.0294
80% gamma percentile (KM)	0.218	90% gamma percentile (KM)	0.257
95% gamma percentile (KM)	0.292	99% gamma percentile (KM)	0.367

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (891.06, α)	822.8	Adjusted Chi Square Value (891.06, β)	821.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.177	95% Gamma Adjusted KM-UCL (use when n<50)	0.178

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.753	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.28	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.121	Mean in Log Scale	-2.313
SD in Original Scale	0.0907	SD in Log Scale	0.633
95% t UCL (assumes normality of ROS data)	0.138	95% Percentile Bootstrap UCL	0.138
95% BCA Bootstrap UCL	0.142	95% Bootstrap t UCL	0.144
95% H-UCL (Log ROS)	0.139		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.854	KM Geo Mean	0.157
KM SD (logged)	0.258	95% Critical H Value (KM-Log)	1.731
KM Standard Error of Mean (logged)	0.0293	95% H-UCL (KM -Log)	0.17
KM SD (logged)	0.258	95% Critical H Value (KM-Log)	1.731
KM Standard Error of Mean (logged)	0.0293		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.12	Mean in Log Scale	-2.283
SD in Original Scale	0.0891	SD in Log Scale	0.527
95% t UCL (Assumes normality)	0.137	95% H-Stat UCL	0.131

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.177	KM H-UCL	0.17
95% KM (BCA) UCL	0.179		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Zinc (mg/kg)

General Statistics

Total Number of Observations	80	Number of Distinct Observations	79
		Number of Missing Observations	0
Minimum	9.991	Mean	25.67
Maximum	138	Median	19.77
SD	20.78	Std. Error of Mean	2.324
Coefficient of Variation	0.81	Skewness	3.94

Normal GOF Test

Shapiro Wilk Test Statistic	0.568	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.256	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	29.54	95% Adjusted-CLT UCL (Chen-1995)	30.59
		95% Modified-t UCL (Johnson-1978)	29.71

Gamma GOF Test

A-D Test Statistic	4.258	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.172	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.1	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.319	k star (bias corrected MLE)	3.203
Theta hat (MLE)	7.735	Theta star (bias corrected MLE)	8.015
nu hat (MLE)	531.1	nu star (bias corrected)	512.5
MLE Mean (bias corrected)	25.67	MLE Sd (bias corrected)	14.34
		Approximate Chi Square Value (0.05)	461
Adjusted Level of Significance	0.047	Adjusted Chi Square Value	460.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	28.54	95% Adjusted Gamma UCL (use when n<50)	28.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.886	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	4.0925E-8	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.118	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0991	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.302	Mean of logged Data	3.087
Maximum of Logged Data	4.927	SD of logged Data	0.494

Appendix D, Table 19. ProUCL Output - Whole Fish Tissue (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	27.45	90% Chebyshev (MVUE) UCL	29.03
95% Chebyshev (MVUE) UCL	30.99	97.5% Chebyshev (MVUE) UCL	33.7
99% Chebyshev (MVUE) UCL	39.02		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	29.49	95% Jackknife UCL	29.54
95% Standard Bootstrap UCL	29.46	95% Bootstrap-t UCL	32.41
95% Hall's Bootstrap UCL	36.08	95% Percentile Bootstrap UCL	29.76
95% BCA Bootstrap UCL	30.65		
90% Chebyshev(Mean, Sd) UCL	32.64	95% Chebyshev(Mean, Sd) UCL	35.8
97.5% Chebyshev(Mean, Sd) UCL	40.18	99% Chebyshev(Mean, Sd) UCL	48.79

Suggested UCL to Use

95% Student's-t UCL	29.54	or 95% Modified-t UCL	29.71

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 3:21:21 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	42
Number of Detects	45	Number of Non-Detects	23
Number of Distinct Detects	41	Number of Distinct Non-Detects	3
Minimum Detect	0.58	Minimum Non-Detect	0.62
Maximum Detect	4.74	Maximum Non-Detect	0.64
Variance Detects	1.138	Percent Non-Detects	33.82%
Mean Detects	1.559	SD Detects	1.067
Median Detects	1.19	CV Detects	0.684
Skewness Detects	1.47	Kurtosis Detects	1.445
Mean of Logged Detects	0.256	SD of Logged Detects	0.599

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.809	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.211	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.236	KM Standard Error of Mean	0.119
KM SD	0.97	95% KM (BCA) UCL	1.45
95% KM (t) UCL	1.434	95% KM (Percentile Bootstrap) UCL	1.419
95% KM (z) UCL	1.432	95% KM Bootstrap t UCL	1.476
90% KM Chebyshev UCL	1.593	95% KM Chebyshev UCL	1.755
97.5% KM Chebyshev UCL	1.979	99% KM Chebyshev UCL	2.42

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.346	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.136	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.133	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.806	k star (bias corrected MLE)	2.634
Theta hat (MLE)	0.556	Theta star (bias corrected MLE)	0.592
nu hat (MLE)	252.6	nu star (bias corrected)	237.1
Mean (detects)	1.559		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.088
Maximum	4.74	Median	0.76
SD	1.096	CV	1.007
k hat (MLE)	0.685	k star (bias corrected MLE)	0.664
Theta hat (MLE)	1.589	Theta star (bias corrected MLE)	1.638
nu hat (MLE)	93.1	nu star (bias corrected)	90.32
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (90.32, α)	69.41	Adjusted Chi Square Value (90.32, β)	69.01
95% Gamma Approximate UCL (use when n>=50)	1.415	95% Gamma Adjusted UCL (use when n<50)	1.424

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.236	SD (KM)	0.97
Variance (KM)	0.941	SE of Mean (KM)	0.119
k hat (KM)	1.624	k star (KM)	1.562
nu hat (KM)	220.8	nu star (KM)	212.4
theta hat (KM)	0.761	theta star (KM)	0.791
80% gamma percentile (KM)	1.904	90% gamma percentile (KM)	2.55
95% gamma percentile (KM)	3.177	99% gamma percentile (KM)	4.587

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (212.40, α)	179.7	Adjusted Chi Square Value (212.40, β)	179
95% Gamma Approximate KM-UCL (use when n>=50)	1.461	95% Gamma Adjusted KM-UCL (use when n<50)	1.466

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.109	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.194	Mean in Log Scale	-0.0976
SD in Original Scale	1.01	SD in Log Scale	0.723
95% t UCL (assumes normality of ROS data)	1.398	95% Percentile Bootstrap UCL	1.412
95% BCA Bootstrap UCL	1.445	95% Bootstrap t UCL	1.441
95% H-UCL (Log ROS)	1.41		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.00173	KM Geo Mean	0.998
KM SD (logged)	0.601	95% Critical H Value (KM-Log)	1.939
KM Standard Error of Mean (logged)	0.0739	95% H-UCL (KM -Log)	1.379
KM SD (logged)	0.601	95% Critical H Value (KM-Log)	1.939
KM Standard Error of Mean (logged)	0.0739		

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.139	Mean in Log Scale	-0.22
SD in Original Scale	1.048	SD in Log Scale	0.828
95% t UCL (Assumes normality)	1.351	95% H-Stat UCL	1.401

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 1.379

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	12
Number of Detects	4	Number of Non-Detects	64
Number of Distinct Detects	3	Number of Distinct Non-Detects	9
Minimum Detect	0.3	Minimum Non-Detect	0.23
Maximum Detect	0.41	Maximum Non-Detect	0.47
Variance Detects	0.00276	Percent Non-Detects	94.12%
Mean Detects	0.333	SD Detects	0.0525
Median Detects	0.31	CV Detects	0.158
Skewness Detects	1.817	Kurtosis Detects	3.293
Mean of Logged Detects	-1.11	SD of Logged Detects	0.149

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.753	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.344	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.236	KM Standard Error of Mean	0.0039
KM SD	0.0272	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.243	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.243	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.248	95% KM Chebyshev UCL	0.253
97.5% KM Chebyshev UCL	0.261	99% KM Chebyshev UCL	0.275

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.632	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.656	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.347	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	58.11	k star (bias corrected MLE)	14.69
Theta hat (MLE)	0.00572	Theta star (bias corrected MLE)	0.0226
nu hat (MLE)	464.9	nu star (bias corrected)	117.6
Mean (detects)	0.333		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0912
Maximum	0.41	Median	0.0646
SD	0.0914	CV	1.003
k hat (MLE)	0.946	k star (bias corrected MLE)	0.914
Theta hat (MLE)	0.0964	Theta star (bias corrected MLE)	0.0998
nu hat (MLE)	128.6	nu star (bias corrected)	124.3
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (124.28, α)	99.54	Adjusted Chi Square Value (124.28, β)	99.06
95% Gamma Approximate UCL (use when n>=50)	0.114	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.236	SD (KM)	0.0272
Variance (KM)	7.3772E-4	SE of Mean (KM)	0.0039
k hat (KM)	75.73	k star (KM)	72.4
nu hat (KM)	10299	nu star (KM)	9846
theta hat (KM)	0.00312	theta star (KM)	0.00326
80% gamma percentile (KM)	0.259	90% gamma percentile (KM)	0.273
95% gamma percentile (KM)	0.284	99% gamma percentile (KM)	0.306

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	9617	Adjusted Chi Square Value (N/A, β)	9612
95% Gamma Approximate KM-UCL (use when n>=50)	0.242	95% Gamma Adjusted KM-UCL (use when n<50)	0.242

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.768	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.329	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.157	Mean in Log Scale	-1.929
SD in Original Scale	0.0643	SD in Log Scale	0.384
95% t UCL (assumes normality of ROS data)	0.17	95% Percentile Bootstrap UCL	0.17
95% BCA Bootstrap UCL	0.171	95% Bootstrap t UCL	0.172
95% H-UCL (Log ROS)	0.17		

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.447	KM Geo Mean	0.235
KM SD (logged)	0.0925	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0133	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.0925	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0133		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.139	Mean in Log Scale	-2.017
SD in Original Scale	0.0552	SD in Log Scale	0.272
95% t UCL (Assumes normality)	0.151	95% H-Stat UCL	0.146

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.243

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	9
Number of Detects	6	Number of Non-Detects	62
Number of Distinct Detects	6	Number of Distinct Non-Detects	3
Minimum Detect	0.28	Minimum Non-Detect	0.27
Maximum Detect	0.61	Maximum Non-Detect	0.57
Variance Detects	0.021	Percent Non-Detects	91.18%
Mean Detects	0.443	SD Detects	0.145
Median Detects	0.445	CV Detects	0.327
Skewness Detects	-0.00627	Kurtosis Detects	-2.566
Mean of Logged Detects	-0.861	SD of Logged Detects	0.341

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.88	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.202	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.286	KM Standard Error of Mean	0.0085
KM SD	0.0634	95% KM (BCA) UCL	0.3
95% KM (t) UCL	0.3	95% KM (Percentile Bootstrap) UCL	0.3
95% KM (z) UCL	0.3	95% KM Bootstrap t UCL	0.3
90% KM Chebyshev UCL	0.311	95% KM Chebyshev UCL	0.323
97.5% KM Chebyshev UCL	0.339	99% KM Chebyshev UCL	0.37

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.435	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.698	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.238	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.332	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	10.74	k star (bias corrected MLE)	5.483
Theta hat (MLE)	0.0413	Theta star (bias corrected MLE)	0.0809
nu hat (MLE)	128.9	nu star (bias corrected)	65.8
Mean (detects)	0.443		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0719
Maximum	0.61	Median	0.01
SD	0.135	CV	1.875
k hat (MLE)	0.545	k star (bias corrected MLE)	0.531
Theta hat (MLE)	0.132	Theta star (bias corrected MLE)	0.135
nu hat (MLE)	74.14	nu star (bias corrected)	72.2
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (72.20, α)	53.64	Adjusted Chi Square Value (72.20, β)	53.29
95% Gamma Approximate UCL (use when n>=50)	0.0968	95% Gamma Adjusted UCL (use when n<50)	0.0975

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.286	SD (KM)	0.0634
Variance (KM)	0.00402	SE of Mean (KM)	0.0085
k hat (KM)	20.31	k star (KM)	19.42
nu hat (KM)	2762	nu star (KM)	2641
theta hat (KM)	0.0141	theta star (KM)	0.0147
80% gamma percentile (KM)	0.338	90% gamma percentile (KM)	0.371
95% gamma percentile (KM)	0.4	99% gamma percentile (KM)	0.458

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	2523	Adjusted Chi Square Value (N/A, β)	2520
95% Gamma Approximate KM-UCL (use when n>=50)	0.299	95% Gamma Adjusted KM-UCL (use when n<50)	0.299

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.879	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.228	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.128	Mean in Log Scale	-2.398
SD in Original Scale	0.122	SD in Log Scale	0.827
95% t UCL (assumes normality of ROS data)	0.152	95% Percentile Bootstrap UCL	0.153
95% BCA Bootstrap UCL	0.156	95% Bootstrap t UCL	0.159
95% H-UCL (Log ROS)	0.159		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.269	KM Geo Mean	0.281
KM SD (logged)	0.159	95% Critical H Value (KM-Log)	1.7
KM Standard Error of Mean (logged)	0.0213	95% H-UCL (KM -Log)	0.294
KM SD (logged)	0.159	95% Critical H Value (KM-Log)	1.7
KM Standard Error of Mean (logged)	0.0213		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.171	Mean in Log Scale	-1.859
SD in Original Scale	0.1	SD in Log Scale	0.369
95% t UCL (Assumes normality)	0.191	95% H-Stat UCL	0.181

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	39
Number of Detects	50	Number of Non-Detects	18
Number of Distinct Detects	39	Number of Distinct Non-Detects	11
Minimum Detect	0.01	Minimum Non-Detect	0.01
Maximum Detect	1.82	Maximum Non-Detect	0.18
Variance Detects	0.131	Percent Non-Detects	26.47%
Mean Detects	0.323	SD Detects	0.362
Median Detects	0.19	CV Detects	1.124
Skewness Detects	2.075	Kurtosis Detects	5.129
Mean of Logged Detects	-1.72	SD of Logged Detects	1.172

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.769	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.125	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.246	KM Standard Error of Mean	0.0409
KM SD	0.333	95% KM (BCA) UCL	0.325
95% KM (t) UCL	0.314	95% KM (Percentile Bootstrap) UCL	0.323
95% KM (z) UCL	0.313	95% KM Bootstrap t UCL	0.337
90% KM Chebyshev UCL	0.369	95% KM Chebyshev UCL	0.424
97.5% KM Chebyshev UCL	0.501	99% KM Chebyshev UCL	0.653

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.446	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.781	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0857	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.129	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.983	k star (bias corrected MLE)	0.937
Theta hat (MLE)	0.328	Theta star (bias corrected MLE)	0.344
nu hat (MLE)	98.28	nu star (bias corrected)	93.71
Mean (detects)	0.323		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.24
Maximum	1.82	Median	0.105
SD	0.34	CV	1.415
k hat (MLE)	0.593	k star (bias corrected MLE)	0.576
Theta hat (MLE)	0.405	Theta star (bias corrected MLE)	0.416
nu hat (MLE)	80.63	nu star (bias corrected)	78.4
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (78.40, α)	59	Adjusted Chi Square Value (78.40, β)	58.64
95% Gamma Approximate UCL (use when n>=50)	0.319	95% Gamma Adjusted UCL (use when n<50)	0.321

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.246	SD (KM)	0.333
Variance (KM)	0.111	SE of Mean (KM)	0.0409
k hat (KM)	0.546	k star (KM)	0.532
nu hat (KM)	74.25	nu star (KM)	72.3
theta hat (KM)	0.451	theta star (KM)	0.463
80% gamma percentile (KM)	0.405	90% gamma percentile (KM)	0.658
95% gamma percentile (KM)	0.925	99% gamma percentile (KM)	1.58

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (72.30, α)	53.72	Adjusted Chi Square Value (72.30, β)	53.38
95% Gamma Approximate KM-UCL (use when n>=50)	0.331	95% Gamma Adjusted KM-UCL (use when n<50)	0.334

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.98	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0562	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.125	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.246	Mean in Log Scale	-2.213
SD in Original Scale	0.336	SD in Log Scale	1.338
95% t UCL (assumes normality of ROS data)	0.314	95% Percentile Bootstrap UCL	0.317
95% BCA Bootstrap UCL	0.328	95% Bootstrap t UCL	0.331
95% H-UCL (Log ROS)	0.381		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.234	KM Geo Mean	0.107
KM SD (logged)	1.369	95% Critical H Value (KM-Log)	2.183
KM Standard Error of Mean (logged)	0.177	95% H-UCL (KM -Log)	0.394
KM SD (logged)	1.369	95% Critical H Value (KM-Log)	2.183
KM Standard Error of Mean (logged)	0.177		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.249	Mean in Log Scale	-2.146
SD in Original Scale	0.334	SD in Log Scale	1.281
95% t UCL (Assumes normality)	0.316	95% H-Stat UCL	0.371

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.331

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	3
Number of Detects	10	Number of Non-Detects	58
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.01	Minimum Non-Detect	0.01
Maximum Detect	0.03	Maximum Non-Detect	0.01
Variance Detects	4.5556E-5	Percent Non-Detects	85.29%
Mean Detects	0.017	SD Detects	0.00675
Median Detects	0.02	CV Detects	0.397
Skewness Detects	0.434	Kurtosis Detects	-0.283
Mean of Logged Detects	-4.149	SD of Logged Detects	0.412

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.802	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.272	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.011	KM Standard Error of Mean	4.4604E-4
KM SD	0.00349	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0118	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0118	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0124	95% KM Chebyshev UCL	0.013
97.5% KM Chebyshev UCL	0.0138	99% KM Chebyshev UCL	0.0155

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.15	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.728	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.314	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.267	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.902	k star (bias corrected MLE)	4.898
Theta hat (MLE)	0.00246	Theta star (bias corrected MLE)	0.00347
nu hat (MLE)	138	nu star (bias corrected)	97.95
Mean (detects)	0.017		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.011
Maximum	0.03	Median	0.01
SD	0.00352	CV	0.319
k hat (MLE)	16.37	k star (bias corrected MLE)	15.66
Theta hat (MLE)	6.7382E-4	Theta star (bias corrected MLE)	7.0448E-4
nu hat (MLE)	2226	nu star (bias corrected)	2129
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (N/A, α)	2023	Adjusted Chi Square Value (N/A, β)	2021
95% Gamma Approximate UCL (use when n>=50)	0.0116	95% Gamma Adjusted UCL (use when n<50)	0.0116

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.011	SD (KM)	0.00349
Variance (KM)	1.2176E-5	SE of Mean (KM)	4.4604E-4
k hat (KM)	9.991	k star (KM)	9.56
nu hat (KM)	1359	nu star (KM)	1300
theta hat (KM)	0.0011	theta star (KM)	0.00115
80% gamma percentile (KM)	0.0139	90% gamma percentile (KM)	0.0158
95% gamma percentile (KM)	0.0175	99% gamma percentile (KM)	0.021

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1217	Adjusted Chi Square Value (N/A, β)	1216
95% Gamma Approximate KM-UCL (use when n>=50)	0.0118	95% Gamma Adjusted KM-UCL (use when n<50)	0.0118

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.317	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00536	Mean in Log Scale	-5.695
SD in Original Scale	0.00586	SD in Log Scale	0.981
95% t UCL (assumes normality of ROS data)	0.00654	95% Percentile Bootstrap UCL	0.00657
95% BCA Bootstrap UCL	0.00682	95% Bootstrap t UCL	0.00686
95% H-UCL (Log ROS)	0.00712		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.538	KM Geo Mean	0.0107
KM SD (logged)	0.22	95% Critical H Value (KM-Log)	1.722
KM Standard Error of Mean (logged)	0.0282	95% H-UCL (KM -Log)	0.0115
KM SD (logged)	0.22	95% Critical H Value (KM-Log)	1.722
KM Standard Error of Mean (logged)	0.0282		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00676	Mean in Log Scale	-5.129
SD in Original Scale	0.00494	SD in Log Scale	0.437
95% t UCL (Assumes normality)	0.00776	95% H-Stat UCL	0.00718

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0118	KM H-UCL	0.0115
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	101	Number of Distinct Observations	10
Number of Detects	22	Number of Non-Detects	79
Number of Distinct Detects	9	Number of Distinct Non-Detects	2

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	0.03	Minimum Non-Detect	0.02
Maximum Detect	0.19	Maximum Non-Detect	0.03
Variance Detects	0.00118	Percent Non-Detects	78.22%
Mean Detects	0.075	SD Detects	0.0343
Median Detects	0.07	CV Detects	0.458
Skewness Detects	1.604	Kurtosis Detects	5.22
Mean of Logged Detects	-2.685	SD of Logged Detects	0.453

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.847	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.032	KM Standard Error of Mean	0.00281
KM SD	0.0276	95% KM (BCA) UCL	0.0367
95% KM (t) UCL	0.0366	95% KM (Percentile Bootstrap) UCL	0.0368
95% KM (z) UCL	0.0366	95% KM Bootstrap t UCL	0.0375
90% KM Chebyshev UCL	0.0404	95% KM Chebyshev UCL	0.0442
97.5% KM Chebyshev UCL	0.0495	99% KM Chebyshev UCL	0.0599

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.617	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.153	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.186	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.456	k star (bias corrected MLE)	4.743
Theta hat (MLE)	0.0137	Theta star (bias corrected MLE)	0.0158
nu hat (MLE)	240.1	nu star (bias corrected)	208.7
Mean (detects)	0.075		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0258
Maximum	0.19	Median	0.01
SD	0.0308	CV	1.194
k hat (MLE)	1.31	k star (bias corrected MLE)	1.278
Theta hat (MLE)	0.0197	Theta star (bias corrected MLE)	0.0202
nu hat (MLE)	264.7	nu star (bias corrected)	258.2
Adjusted Level of Significance (β)	0.0476		
Approximate Chi Square Value (258.17, α)	222	Adjusted Chi Square Value (258.17, β)	221.5
95% Gamma Approximate UCL (use when n>=50)	0.03	95% Gamma Adjusted UCL (use when n<50)	0.0301

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.032	SD (KM)	0.0276
Variance (KM)	7.6044E-4	SE of Mean (KM)	0.00281
k hat (KM)	1.345	k star (KM)	1.312
nu hat (KM)	271.7	nu star (KM)	264.9
theta hat (KM)	0.0238	theta star (KM)	0.0244
80% gamma percentile (KM)	0.0502	90% gamma percentile (KM)	0.0689
95% gamma percentile (KM)	0.0872	99% gamma percentile (KM)	0.129

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (264.94, α)	228.2	Adjusted Chi Square Value (264.94, β)	227.8
95% Gamma Approximate KM-UCL (use when n>=50)	0.0371	95% Gamma Adjusted KM-UCL (use when n<50)	0.0372

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.92	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.161	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0292	Mean in Log Scale	-3.958
SD in Original Scale	0.0302	SD in Log Scale	0.927
95% t UCL (assumes normality of ROS data)	0.0341	95% Percentile Bootstrap UCL	0.0342
95% BCA Bootstrap UCL	0.0349	95% Bootstrap t UCL	0.0353
95% H-UCL (Log ROS)	0.0358		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.645	KM Geo Mean	0.0261
KM SD (logged)	0.547	95% Critical H Value (KM-Log)	1.858
KM Standard Error of Mean (logged)	0.0557	95% H-UCL (KM -Log)	0.0336
KM SD (logged)	0.547	95% Critical H Value (KM-Log)	1.858
KM Standard Error of Mean (logged)	0.0557		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0264	Mean in Log Scale	-4.002
SD in Original Scale	0.0303	SD in Log Scale	0.75
95% t UCL (Assumes normality)	0.0314	95% H-Stat UCL	0.0281

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.0371	95% GROS Approximate Gamma UCL	0.03

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Chromium (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	24
Number of Detects	32	Number of Non-Detects	36
Number of Distinct Detects	22	Number of Distinct Non-Detects	6
Minimum Detect	0.07	Minimum Non-Detect	0.06
Maximum Detect	1.16	Maximum Non-Detect	0.6
Variance Detects	0.0915	Percent Non-Detects	52.94%
Mean Detects	0.348	SD Detects	0.302
Median Detects	0.175	CV Detects	0.87
Skewness Detects	0.961	Kurtosis Detects	0.0832
Mean of Logged Detects	-1.465	SD of Logged Detects	0.945

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.836	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.241	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.2	KM Standard Error of Mean	0.031
KM SD	0.25	95% KM (BCA) UCL	0.254
95% KM (t) UCL	0.251	95% KM (Percentile Bootstrap) UCL	0.252
95% KM (z) UCL	0.251	95% KM Bootstrap t UCL	0.263
90% KM Chebyshev UCL	0.293	95% KM Chebyshev UCL	0.335
97.5% KM Chebyshev UCL	0.393	99% KM Chebyshev UCL	0.508

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.569	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.767	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.184	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.159	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.368	k star (bias corrected MLE)	1.261
Theta hat (MLE)	0.254	Theta star (bias corrected MLE)	0.276
nu hat (MLE)	87.57	nu star (bias corrected)	80.7
Mean (detects)	0.348		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	0.01	Mean	0.17
Maximum	1.16	Median	0.01
SD	0.266	CV	1.57
k hat (MLE)	0.482	k star (bias corrected MLE)	0.47
Theta hat (MLE)	0.352	Theta star (bias corrected MLE)	0.361
nu hat (MLE)	65.51	nu star (bias corrected)	63.96
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (63.96, α)	46.56	Adjusted Chi Square Value (63.96, β)	46.24
95% Gamma Approximate UCL (use when n>=50)	0.233	95% Gamma Adjusted UCL (use when n<50)	0.235

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.2	SD (KM)	0.25
Variance (KM)	0.0624	SE of Mean (KM)	0.031
k hat (KM)	0.638	k star (KM)	0.62
nu hat (KM)	86.84	nu star (KM)	84.34
theta hat (KM)	0.313	theta star (KM)	0.322
80% gamma percentile (KM)	0.329	90% gamma percentile (KM)	0.515
95% gamma percentile (KM)	0.71	99% gamma percentile (KM)	1.178

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (84.34, α)	64.17	Adjusted Chi Square Value (84.34, β)	63.79
95% Gamma Approximate KM-UCL (use when n>=50)	0.262	95% Gamma Adjusted KM-UCL (use when n<50)	0.264

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.877	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.154	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.18	Mean in Log Scale	-2.668
SD in Original Scale	0.26	SD in Log Scale	1.447
95% t UCL (assumes normality of ROS data)	0.233	95% Percentile Bootstrap UCL	0.233
95% BCA Bootstrap UCL	0.236	95% Bootstrap t UCL	0.244
95% H-UCL (Log ROS)	0.296		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.148	KM Geo Mean	0.117
KM SD (logged)	0.928	95% Critical H Value (KM-Log)	2.213
KM Standard Error of Mean (logged)	0.116	95% H-UCL (KM -Log)	0.231
KM SD (logged)	0.928	95% Critical H Value (KM-Log)	2.213
KM Standard Error of Mean (logged)	0.116		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.199	Mean in Log Scale	-2.358
SD in Original Scale	0.257	SD in Log Scale	1.213
95% t UCL (Assumes normality)	0.251	95% H-Stat UCL	0.272

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.335

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	3
Number of Detects	1	Number of Non-Detects	67
Number of Distinct Detects	1	Number of Distinct Non-Detects	3

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Cobalt (mg/kg) was not processed!

Copper (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	38
Number of Detects	49	Number of Non-Detects	19
Number of Distinct Detects	34	Number of Distinct Non-Detects	14
Minimum Detect	0.18	Minimum Non-Detect	0.17
Maximum Detect	1.4	Maximum Non-Detect	0.66
Variance Detects	0.069	Percent Non-Detects	27.94%
Mean Detects	0.523	SD Detects	0.263
Median Detects	0.48	CV Detects	0.502
Skewness Detects	1.51	Kurtosis Detects	2.691
Mean of Logged Detects	-0.756	SD of Logged Detects	0.467

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.164	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.126	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.446	KM Standard Error of Mean	0.0322
KM SD	0.259	95% KM (BCA) UCL	0.504
95% KM (t) UCL	0.499	95% KM (Percentile Bootstrap) UCL	0.499
95% KM (z) UCL	0.499	95% KM Bootstrap t UCL	0.504
90% KM Chebyshev UCL	0.542	95% KM Chebyshev UCL	0.586
97.5% KM Chebyshev UCL	0.647	99% KM Chebyshev UCL	0.766

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.492	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.101	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.127	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.775	k star (bias corrected MLE)	4.497
Theta hat (MLE)	0.11	Theta star (bias corrected MLE)	0.116
nu hat (MLE)	468	nu star (bias corrected)	440.7
Mean (detects)	0.523		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0165	Mean	0.43
Maximum	1.4	Median	0.365
SD	0.274	CV	0.637
k hat (MLE)	2.378	k star (bias corrected MLE)	2.283
Theta hat (MLE)	0.181	Theta star (bias corrected MLE)	0.188
nu hat (MLE)	323.4	nu star (bias corrected)	310.5
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (310.48, α)	270.7	Adjusted Chi Square Value (310.48, β)	269.9
95% Gamma Approximate UCL (use when n>=50)	0.493	95% Gamma Adjusted UCL (use when n<50)	0.494

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.446	SD (KM)	0.259
Variance (KM)	0.0669	SE of Mean (KM)	0.0322
k hat (KM)	2.967	k star (KM)	2.846
nu hat (KM)	403.5	nu star (KM)	387
theta hat (KM)	0.15	theta star (KM)	0.157
80% gamma percentile (KM)	0.64	90% gamma percentile (KM)	0.8
95% gamma percentile (KM)	0.949	99% gamma percentile (KM)	1.275

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (387.01, α)	342.4	Adjusted Chi Square Value (387.01, β)	341.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.504	95% Gamma Adjusted KM-UCL (use when n<50)	0.505

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0809	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.126	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.444	Mean in Log Scale	-0.956
SD in Original Scale	0.259	SD in Log Scale	0.531
95% t UCL (assumes normality of ROS data)	0.496	95% Percentile Bootstrap UCL	0.494
95% BCA Bootstrap UCL	0.503	95% Bootstrap t UCL	0.506
95% H-UCL (Log ROS)	0.5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.955	KM Geo Mean	0.385
KM SD (logged)	0.536	95% Critical H Value (KM-Log)	1.892
KM Standard Error of Mean (logged)	0.0687	95% H-UCL (KM -Log)	0.503
KM SD (logged)	0.536	95% Critical H Value (KM-Log)	1.892
KM Standard Error of Mean (logged)	0.0687		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.429	Mean in Log Scale	-1.036
SD in Original Scale	0.272	SD in Log Scale	0.634
95% t UCL (Assumes normality)	0.484	95% H-Stat UCL	0.505

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.504	95% GROS Approximate Gamma UCL	0.493

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	60
Number of Detects	55	Number of Non-Detects	13
Number of Distinct Detects	50	Number of Distinct Non-Detects	13
Minimum Detect	0.59	Minimum Non-Detect	1.64
Maximum Detect	18.2	Maximum Non-Detect	7.06
Variance Detects	5.068	Percent Non-Detects	19.12%
Mean Detects	3.512	SD Detects	2.251
Median Detects	3.43	CV Detects	0.641
Skewness Detects	5.254	Kurtosis Detects	34.48
Mean of Logged Detects	1.149	SD of Logged Detects	0.445

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.549	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.119	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	3.275	KM Standard Error of Mean	0.261
KM SD	2.104	95% KM (BCA) UCL	3.753
95% KM (t) UCL	3.711	95% KM (Percentile Bootstrap) UCL	3.736
95% KM (z) UCL	3.705	95% KM Bootstrap t UCL	4.008
90% KM Chebyshev UCL	4.059	95% KM Chebyshev UCL	4.414
97.5% KM Chebyshev UCL	4.907	99% KM Chebyshev UCL	5.875

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.796	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.152	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.12	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.813	k star (bias corrected MLE)	4.563
Theta hat (MLE)	0.73	Theta star (bias corrected MLE)	0.77
nu hat (MLE)	529.4	nu star (bias corrected)	501.9
Mean (detects)	3.512		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.59	Mean	3.227
Maximum	18.2	Median	2.968
SD	2.126	CV	0.659
k hat (MLE)	4.284	k star (bias corrected MLE)	4.104
Theta hat (MLE)	0.753	Theta star (bias corrected MLE)	0.786
nu hat (MLE)	582.6	nu star (bias corrected)	558.2
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (558.20, α)	504.4	Adjusted Chi Square Value (558.20, β)	503.3
95% Gamma Approximate UCL (use when n>=50)	3.572	95% Gamma Adjusted UCL (use when n<50)	3.579

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	3.275	SD (KM)	2.104
Variance (KM)	4.425	SE of Mean (KM)	0.261
k hat (KM)	2.424	k star (KM)	2.327
nu hat (KM)	329.7	nu star (KM)	316.5
theta hat (KM)	1.351	theta star (KM)	1.408
80% gamma percentile (KM)	4.816	90% gamma percentile (KM)	6.15
95% gamma percentile (KM)	7.411	99% gamma percentile (KM)	10.18

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (316.47, α)	276.3	Adjusted Chi Square Value (316.47, β)	275.4
95% Gamma Approximate KM-UCL (use when n>=50)	3.752	95% Gamma Adjusted KM-UCL (use when n<50)	3.763

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.905	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.8438E-4	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.127	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.119	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.269	Mean in Log Scale	1.079
SD in Original Scale	2.093	SD in Log Scale	0.437
95% t UCL (assumes normality of ROS data)	3.692	95% Percentile Bootstrap UCL	3.722
95% BCA Bootstrap UCL	3.886	95% Bootstrap t UCL	4.022
95% H-UCL (Log ROS)	3.567		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.066	KM Geo Mean	2.904
KM SD (logged)	0.485	95% Critical H Value (KM-Log)	1.858
KM Standard Error of Mean (logged)	0.0657	95% H-UCL (KM -Log)	3.647
KM SD (logged)	0.485	95% Critical H Value (KM-Log)	1.858
KM Standard Error of Mean (logged)	0.0657		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.187	Mean in Log Scale	1.027
SD in Original Scale	2.156	SD in Log Scale	0.504
95% t UCL (Assumes normality)	3.623	95% H-Stat UCL	3.558

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	3.711	KM H-UCL	3.647
95% KM (BCA) UCL	3.753		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	101	Number of Distinct Observations	8
Number of Detects	5	Number of Non-Detects	96
Number of Distinct Detects	4	Number of Distinct Non-Detects	5

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	0.24	Minimum Non-Detect	0.02
Maximum Detect	0.99	Maximum Non-Detect	0.46
Variance Detects	0.104	Percent Non-Detects	95.05%
Mean Detects	0.416	SD Detects	0.323
Median Detects	0.26	CV Detects	0.776
Skewness Detects	2.175	Kurtosis Detects	4.768
Mean of Logged Detects	-1.048	SD of Logged Detects	0.592

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.638	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.405	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0398	KM Standard Error of Mean	0.012
KM SD	0.107	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0597	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0595	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0757	95% KM Chebyshev UCL	0.092
97.5% KM Chebyshev UCL	0.115	99% KM Chebyshev UCL	0.159

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.92	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.683	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.378	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.359	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.082	k star (bias corrected MLE)	1.366
Theta hat (MLE)	0.135	Theta star (bias corrected MLE)	0.305
nu hat (MLE)	30.82	nu star (bias corrected)	13.66
Mean (detects)	0.416		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0301
Maximum	0.99	Median	0.01
SD	0.11	CV	3.639
k hat (MLE)	0.658	k star (bias corrected MLE)	0.645
Theta hat (MLE)	0.0457	Theta star (bias corrected MLE)	0.0466
nu hat (MLE)	133	nu star (bias corrected)	130.4
Adjusted Level of Significance (β)	0.0476		
Approximate Chi Square Value (130.39, α)	105	Adjusted Chi Square Value (130.39, β)	104.7
95% Gamma Approximate UCL (use when n>=50)	0.0374	95% Gamma Adjusted UCL (use when n<50)	0.0375

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0398	SD (KM)	0.107
Variance (KM)	0.0115	SE of Mean (KM)	0.012
k hat (KM)	0.137	k star (KM)	0.14
nu hat (KM)	27.7	nu star (KM)	28.21
theta hat (KM)	0.29	theta star (KM)	0.285
80% gamma percentile (KM)	0.0407	90% gamma percentile (KM)	0.117
95% gamma percentile (KM)	0.222	99% gamma percentile (KM)	0.532

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (28.21, α)	17.09	Adjusted Chi Square Value (28.21, β)	16.97
95% Gamma Approximate KM-UCL (use when n>=50)	0.0657	95% Gamma Adjusted KM-UCL (use when n<50)	0.0661

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.711	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.341	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0428	Mean in Log Scale	-4.356
SD in Original Scale	0.111	SD in Log Scale	1.527
95% t UCL (assumes normality of ROS data)	0.0611	95% Percentile Bootstrap UCL	0.0631
95% BCA Bootstrap UCL	0.0717	95% Bootstrap t UCL	0.0816
95% H-UCL (Log ROS)	0.0626		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.768	KM Geo Mean	0.0231
KM SD (logged)	0.636	95% Critical H Value (KM-Log)	1.915
KM Standard Error of Mean (logged)	0.0711	95% H-UCL (KM -Log)	0.0319
KM SD (logged)	0.636	95% Critical H Value (KM-Log)	1.915
KM Standard Error of Mean (logged)	0.0711		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0997	Mean in Log Scale	-2.874
SD in Original Scale	0.111	SD in Log Scale	1.241
95% t UCL (Assumes normality)	0.118	95% H-Stat UCL	0.165

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.0319

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Manganese (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	52
		Number of Missing Observations	0
Minimum	0.08	Mean	0.929
Maximum	15.6	Median	0.43
SD	1.965	Std. Error of Mean	0.238
Coefficient of Variation	2.116	Skewness	6.492

Normal GOF Test

Shapiro Wilk Test Statistic	0.388	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.333	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.326	95% Adjusted-CLT UCL (Chen-1995)	1.521
		95% Modified-t UCL (Johnson-1978)	1.357

Gamma GOF Test

A-D Test Statistic	2.978	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.787	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.169	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.112	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.867	k star (bias corrected MLE)	0.838
Theta hat (MLE)	1.072	Theta star (bias corrected MLE)	1.108
nu hat (MLE)	117.9	nu star (bias corrected)	114
MLE Mean (bias corrected)	0.929	MLE Sd (bias corrected)	1.014
		Approximate Chi Square Value (0.05)	90.34
Adjusted Level of Significance	0.0465	Adjusted Chi Square Value	89.89

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.172	95% Adjusted Gamma UCL (use when n<50)	1.178

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0256	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.112	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.107	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.526	Mean of logged Data	-0.752
Maximum of Logged Data	2.747	SD of logged Data	1.035

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Lognormal Distribution

95% H-UCL	1.072	90% Chebyshev (MVUE) UCL	1.156
95% Chebyshev (MVUE) UCL	1.319	97.5% Chebyshev (MVUE) UCL	1.545
99% Chebyshev (MVUE) UCL	1.989		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	1.321	95% Jackknife UCL	1.326
95% Standard Bootstrap UCL	1.324	95% Bootstrap-t UCL	1.908
95% Hall's Bootstrap UCL	2.878	95% Percentile Bootstrap UCL	1.372
95% BCA Bootstrap UCL	1.619		
90% Chebyshev(Mean, Sd) UCL	1.644	95% Chebyshev(Mean, Sd) UCL	1.967
97.5% Chebyshev(Mean, Sd) UCL	2.417	99% Chebyshev(Mean, Sd) UCL	3.3

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 1.967

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	62
		Number of Missing Observations	0
Minimum	0.00707	Mean	0.0435
Maximum	0.172	Median	0.0323
SD	0.0328	Std. Error of Mean	0.00398
Coefficient of Variation	0.754	Skewness	1.716

Normal GOF Test

Shapiro Wilk Test Statistic	0.829	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	1.404E-10	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.182	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.107	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0501	95% Adjusted-CLT UCL (Chen-1995)	0.0509
		95% Modified-t UCL (Johnson-1978)	0.0503

Gamma GOF Test

A-D Test Statistic	0.835	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0944	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.109	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	2.253	k star (bias corrected MLE)	2.163
Theta hat (MLE)	0.0193	Theta star (bias corrected MLE)	0.0201
nu hat (MLE)	306.4	nu star (bias corrected)	294.2
MLE Mean (bias corrected)	0.0435	MLE Sd (bias corrected)	0.0296
		Approximate Chi Square Value (0.05)	255.5
Adjusted Level of Significance	0.0465	Adjusted Chi Square Value	254.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	0.0501	95% Adjusted Gamma UCL (use when n<50)	0.0502

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.745	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0613	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.107	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4.952	Mean of logged Data	-3.373
Maximum of Logged Data	-1.76	SD of logged Data	0.69

Assuming Lognormal Distribution

95% H-UCL	0.0515	90% Chebyshev (MVUE) UCL	0.0553
95% Chebyshev (MVUE) UCL	0.0607	97.5% Chebyshev (MVUE) UCL	0.0682
99% Chebyshev (MVUE) UCL	0.0829		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.05	95% Jackknife UCL	0.0501
95% Standard Bootstrap UCL	0.0499	95% Bootstrap-t UCL	0.0515
95% Hall's Bootstrap UCL	0.0516	95% Percentile Bootstrap UCL	0.0505
95% BCA Bootstrap UCL	0.0511		
90% Chebyshev(Mean, Sd) UCL	0.0554	95% Chebyshev(Mean, Sd) UCL	0.0608
97.5% Chebyshev(Mean, Sd) UCL	0.0683	99% Chebyshev(Mean, Sd) UCL	0.083

Suggested UCL to Use

95% Approximate Gamma UCL	0.0501

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nickel (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	6
Number of Detects	11	Number of Non-Detects	57
Number of Distinct Detects	6	Number of Distinct Non-Detects	2
Minimum Detect	0.07	Minimum Non-Detect	0.07
Maximum Detect	0.14	Maximum Non-Detect	0.14
Variance Detects	4.2000E-4	Percent Non-Detects	83.82%
Mean Detects	0.09	SD Detects	0.0205
Median Detects	0.08	CV Detects	0.228
Skewness Detects	1.619	Kurtosis Detects	2.88
Mean of Logged Detects	-2.428	SD of Logged Detects	0.206

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.832	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0733	KM Standard Error of Mean	0.00138
KM SD	0.0108	95% KM (BCA) UCL	0.0754
95% KM (t) UCL	0.0756	95% KM (Percentile Bootstrap) UCL	0.0757
95% KM (z) UCL	0.0755	95% KM Bootstrap t UCL	0.0773
90% KM Chebyshev UCL	0.0774	95% KM Chebyshev UCL	0.0793
97.5% KM Chebyshev UCL	0.0819	99% KM Chebyshev UCL	0.087

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.608	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.238	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	24.51	k star (bias corrected MLE)	17.89
Theta hat (MLE)	0.00367	Theta star (bias corrected MLE)	0.00503
nu hat (MLE)	539.3	nu star (bias corrected)	393.5
Mean (detects)	0.09		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	0.01	Mean	0.0353
Maximum	0.14	Median	0.0247
SD	0.0298	CV	0.847
k hat (MLE)	1.609	k star (bias corrected MLE)	1.548
Theta hat (MLE)	0.0219	Theta star (bias corrected MLE)	0.0228
nu hat (MLE)	218.9	nu star (bias corrected)	210.6
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (210.56, α)	178	Adjusted Chi Square Value (210.56, β)	177.3
95% Gamma Approximate UCL (use when n>=50)	0.0417	95% Gamma Adjusted UCL (use when n<50)	0.0419

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0733	SD (KM)	0.0108
Variance (KM)	1.1661E-4	SE of Mean (KM)	0.00138
k hat (KM)	46.04	k star (KM)	44.01
nu hat (KM)	6261	nu star (KM)	5986
theta hat (KM)	0.00159	theta star (KM)	0.00166
80% gamma percentile (KM)	0.0824	90% gamma percentile (KM)	0.0877
95% gamma percentile (KM)	0.0923	99% gamma percentile (KM)	0.101

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	5807	Adjusted Chi Square Value (N/A, β)	5803
95% Gamma Approximate KM-UCL (use when n>=50)	0.0755	95% Gamma Adjusted KM-UCL (use when n<50)	0.0756

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.227	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0477	Mean in Log Scale	-3.152
SD in Original Scale	0.0237	SD in Log Scale	0.47
95% t UCL (assumes normality of ROS data)	0.0525	95% Percentile Bootstrap UCL	0.0528
95% BCA Bootstrap UCL	0.053	95% Bootstrap t UCL	0.0532
95% H-UCL (Log ROS)	0.0531		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.622	KM Geo Mean	0.0727
KM SD (logged)	0.116	95% Critical H Value (KM-Log)	1.686
KM Standard Error of Mean (logged)	0.0149	95% H-UCL (KM -Log)	0.075
KM SD (logged)	0.116	95% Critical H Value (KM-Log)	1.686
KM Standard Error of Mean (logged)	0.0149		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0444	Mean in Log Scale	-3.193
SD in Original Scale	0.0221	SD in Log Scale	0.357
95% t UCL (Assumes normality)	0.0489	95% H-Stat UCL	0.0473

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (t) UCL 0.0756

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	15
Number of Detects	13	Number of Non-Detects	55
Number of Distinct Detects	11	Number of Distinct Non-Detects	5
Minimum Detect	0.74	Minimum Non-Detect	0.71
Maximum Detect	1.52	Maximum Non-Detect	1.42
Variance Detects	0.0497	Percent Non-Detects	80.88%
Mean Detects	1.012	SD Detects	0.223
Median Detects	0.97	CV Detects	0.22
Skewness Detects	0.791	Kurtosis Detects	0.75
Mean of Logged Detects	-0.00918	SD of Logged Detects	0.214

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.123	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.768	KM Standard Error of Mean	0.0193
KM SD	0.152	95% KM (BCA) UCL	0.805
95% KM (t) UCL	0.801	95% KM (Percentile Bootstrap) UCL	0.801
95% KM (z) UCL	0.8	95% KM Bootstrap t UCL	0.81
90% KM Chebyshev UCL	0.826	95% KM Chebyshev UCL	0.852
97.5% KM Chebyshev UCL	0.889	99% KM Chebyshev UCL	0.96

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.267	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.733	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.128	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.236	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	23.51	k star (bias corrected MLE)	18.14
Theta hat (MLE)	0.0431	Theta star (bias corrected MLE)	0.0558
nu hat (MLE)	611.3	nu star (bias corrected)	471.6
Mean (detects)	1.012		

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.43
Maximum	1.52	Median	0.379
SD	0.359	CV	0.834
k hat (MLE)	0.887	k star (bias corrected MLE)	0.858
Theta hat (MLE)	0.485	Theta star (bias corrected MLE)	0.502
nu hat (MLE)	120.7	nu star (bias corrected)	116.7
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (116.71, α)	92.77	Adjusted Chi Square Value (116.71, β)	92.3
95% Gamma Approximate UCL (use when n>=50)	0.542	95% Gamma Adjusted UCL (use when n<50)	0.544

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.768	SD (KM)	0.152
Variance (KM)	0.0231	SE of Mean (KM)	0.0193
k hat (KM)	25.61	k star (KM)	24.49
nu hat (KM)	3482	nu star (KM)	3330
theta hat (KM)	0.03	theta star (KM)	0.0314
80% gamma percentile (KM)	0.895	90% gamma percentile (KM)	0.973
95% gamma percentile (KM)	1.041	99% gamma percentile (KM)	1.175

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	3197	Adjusted Chi Square Value (N/A, β)	3194
95% Gamma Approximate KM-UCL (use when n>=50)	0.8	95% Gamma Adjusted KM-UCL (use when n<50)	0.801

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.12	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.567	Mean in Log Scale	-0.666
SD in Original Scale	0.268	SD in Log Scale	0.442
95% t UCL (assumes normality of ROS data)	0.621	95% Percentile Bootstrap UCL	0.621
95% BCA Bootstrap UCL	0.623	95% Bootstrap t UCL	0.626
95% H-UCL (Log ROS)	0.625		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.278	KM Geo Mean	0.757
KM SD (logged)	0.16	95% Critical H Value (KM-Log)	1.7
KM Standard Error of Mean (logged)	0.0202	95% H-UCL (KM -Log)	0.793
KM SD (logged)	0.16	95% Critical H Value (KM-Log)	1.7
KM Standard Error of Mean (logged)	0.0202		

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.495	Mean in Log Scale	-0.803
SD in Original Scale	0.273	SD in Log Scale	0.407
95% t UCL (Assumes normality)	0.551	95% H-Stat UCL	0.533

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.801

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	7
Number of Detects	7	Number of Non-Detects	61
Number of Distinct Detects	6	Number of Distinct Non-Detects	2
Minimum Detect	0.15	Minimum Non-Detect	0.15
Maximum Detect	0.23	Maximum Non-Detect	0.3
Variance Detects	8.6190E-4	Percent Non-Detects	89.71%
Mean Detects	0.184	SD Detects	0.0294
Median Detects	0.17	CV Detects	0.159
Skewness Detects	0.516	Kurtosis Detects	-1.205
Mean of Logged Detects	-1.702	SD of Logged Detects	0.157

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.154	KM Standard Error of Mean	0.00181
KM SD	0.0137	95% KM (BCA) UCL	0.157
95% KM (t) UCL	0.157	95% KM (Percentile Bootstrap) UCL	0.157
95% KM (z) UCL	0.157	95% KM Bootstrap t UCL	0.158
90% KM Chebyshev UCL	0.159	95% KM Chebyshev UCL	0.161
97.5% KM Chebyshev UCL	0.165	99% KM Chebyshev UCL	0.172

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.34	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.708	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.262	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.311	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	47.15	k star (bias corrected MLE)	27.04
Theta hat (MLE)	0.00391	Theta star (bias corrected MLE)	0.00682
nu hat (MLE)	660	nu star (bias corrected)	378.5
Mean (detects)	0.184		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0601
Maximum	0.23	Median	0.0416
SD	0.0574	CV	0.954
k hat (MLE)	1.095	k star (bias corrected MLE)	1.057
Theta hat (MLE)	0.0549	Theta star (bias corrected MLE)	0.0569
nu hat (MLE)	148.9	nu star (bias corrected)	143.7
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (143.68, α)	117	Adjusted Chi Square Value (143.68, β)	116.5
95% Gamma Approximate UCL (use when n>=50)	0.0739	95% Gamma Adjusted UCL (use when n<50)	0.0742

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.154	SD (KM)	0.0137
Variance (KM)	1.8717E-4	SE of Mean (KM)	0.00181
k hat (KM)	126	k star (KM)	120.5
nu hat (KM)	17139	nu star (KM)	16384
theta hat (KM)	0.00122	theta star (KM)	0.00127
80% gamma percentile (KM)	0.165	90% gamma percentile (KM)	0.172
95% gamma percentile (KM)	0.177	99% gamma percentile (KM)	0.188

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	16088	Adjusted Chi Square Value (N/A, β)	16081
95% Gamma Approximate KM-UCL (use when n>=50)	0.156	95% Gamma Adjusted KM-UCL (use when n<50)	0.156

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0893	Mean in Log Scale	-2.522
SD in Original Scale	0.0432	SD in Log Scale	0.466
95% t UCL (assumes normality of ROS data)	0.0981	95% Percentile Bootstrap UCL	0.0981
95% BCA Bootstrap UCL	0.098	95% Bootstrap t UCL	0.0993
95% H-UCL (Log ROS)	0.0994		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.877	KM Geo Mean	0.153
KM SD (logged)	0.0759	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.01	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.0759	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.01		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0874	Mean in Log Scale	-2.489
SD in Original Scale	0.0354	SD in Log Scale	0.285
95% t UCL (Assumes normality)	0.0945	95% H-Stat UCL	0.0919

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.157

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Thallium (mg/kg)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	5
Number of Detects	2	Number of Non-Detects	66
Number of Distinct Detects	2	Number of Distinct Non-Detects	3
Minimum Detect	0.55	Minimum Non-Detect	0.3
Maximum Detect	0.69	Maximum Non-Detect	0.6
Variance Detects	0.0098	Percent Non-Detects	97.06%
Mean Detects	0.62	SD Detects	0.099
Median Detects	0.62	CV Detects	0.16
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.484	SD of Logged Detects	0.16

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.309	KM Standard Error of Mean	0.00954
KM SD	0.0555	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.325	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.325	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.338	95% KM Chebyshev UCL	0.351
97.5% KM Chebyshev UCL	0.369	99% KM Chebyshev UCL	0.404

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	78.11	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00794	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	312.5	nu star (bias corrected)	N/A
Mean (detects)	0.62		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.309	SD (KM)	0.0555
Variance (KM)	0.00308	SE of Mean (KM)	0.00954
k hat (KM)	31.09	k star (KM)	29.73
nu hat (KM)	4229	nu star (KM)	4043
theta hat (KM)	0.00995	theta star (KM)	0.0104
80% gamma percentile (KM)	0.356	90% gamma percentile (KM)	0.384
95% gamma percentile (KM)	0.408	99% gamma percentile (KM)	0.457

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0465
Approximate Chi Square Value (N/A, α)	3897	Adjusted Chi Square Value (N/A, β)	3893
95% Gamma Approximate KM-UCL (use when n>=50)	0.321	95% Gamma Adjusted KM-UCL (use when n<50)	0.321

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.216	Mean in Log Scale	-1.658
SD in Original Scale	0.116	SD in Log Scale	0.499
95% t UCL (assumes normality of ROS data)	0.239	95% Percentile Bootstrap UCL	0.239
95% BCA Bootstrap UCL	0.242	95% Bootstrap t UCL	0.244
95% H-UCL (Log ROS)	0.242		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.183	KM Geo Mean	0.306
KM SD (logged)	0.123	95% Critical H Value (KM-Log)	1.688
KM Standard Error of Mean (logged)	0.0212	95% H-UCL (KM -Log)	0.317
KM SD (logged)	0.123	95% Critical H Value (KM-Log)	1.688
KM Standard Error of Mean (logged)	0.0212		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.171	Mean in Log Scale	-1.816
SD in Original Scale	0.0817	SD in Log Scale	0.248
95% t UCL (Assumes normality)	0.187	95% H-Stat UCL	0.177

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.325	KM H-UCL	0.317
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	101	Number of Distinct Observations	92
Number of Detects	95	Number of Non-Detects	6
Number of Distinct Detects	86	Number of Distinct Non-Detects	6
Minimum Detect	3.06	Minimum Non-Detect	2.88
Maximum Detect	94.8	Maximum Non-Detect	3.19
Variance Detects	105.1	Percent Non-Detects	5.941%
Mean Detects	10.08	SD Detects	10.25
Median Detects	7.62	CV Detects	1.017
Skewness Detects	6.225	Kurtosis Detects	49.98
Mean of Logged Detects	2.095	SD of Logged Detects	0.592

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.519	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.247	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0911	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.652	KM Standard Error of Mean	1.004
KM SD	10.04	95% KM (BCA) UCL	11.61
95% KM (t) UCL	11.32	95% KM (Percentile Bootstrap) UCL	11.41
95% KM (z) UCL	11.3	95% KM Bootstrap t UCL	12.64
90% KM Chebyshev UCL	12.66	95% KM Chebyshev UCL	14.03
97.5% KM Chebyshev UCL	15.92	99% KM Chebyshev UCL	19.64

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.389	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.762	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.135	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0928	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.48	k star (bias corrected MLE)	2.408
Theta hat (MLE)	4.064	Theta star (bias corrected MLE)	4.185
nu hat (MLE)	471.1	nu star (bias corrected)	457.6
Mean (detects)	10.08		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	9.48
Maximum	94.8	Median	7.23
SD	10.23	CV	1.079
k hat (MLE)	1.041	k star (bias corrected MLE)	1.017
Theta hat (MLE)	9.106	Theta star (bias corrected MLE)	9.324
nu hat (MLE)	210.3	nu star (bias corrected)	205.4
Adjusted Level of Significance (β)	0.0476		
Approximate Chi Square Value (205.38, α)	173.2	Adjusted Chi Square Value (205.38, β)	172.8
95% Gamma Approximate UCL (use when n>=50)	11.24	95% Gamma Adjusted UCL (use when n<50)	11.27

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.652	SD (KM)	10.04
Variance (KM)	100.7	SE of Mean (KM)	1.004
k hat (KM)	0.925	k star (KM)	0.904
nu hat (KM)	186.8	nu star (KM)	182.6
theta hat (KM)	10.44	theta star (KM)	10.68
80% gamma percentile (KM)	15.65	90% gamma percentile (KM)	22.78
95% gamma percentile (KM)	29.97	99% gamma percentile (KM)	46.78

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (182.60, α)	152.3	Adjusted Chi Square Value (182.60, β)	151.9
95% Gamma Approximate KM-UCL (use when n>=50)	11.57	95% Gamma Adjusted KM-UCL (use when n<50)	11.6

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.00137	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0785	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0911	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.606	Mean in Log Scale	2.016
SD in Original Scale	10.12	SD in Log Scale	0.656
95% t UCL (assumes normality of ROS data)	11.28	95% Percentile Bootstrap UCL	11.44
95% BCA Bootstrap UCL	12.64	95% Bootstrap t UCL	12.55
95% H-UCL (Log ROS)	10.56		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.034	KM Geo Mean	7.646
KM SD (logged)	0.62	95% Critical H Value (KM-Log)	1.904
KM Standard Error of Mean (logged)	0.0621	95% H-UCL (KM -Log)	10.43
KM SD (logged)	0.62	95% Critical H Value (KM-Log)	1.904
KM Standard Error of Mean (logged)	0.0621		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	9.569	Mean in Log Scale	1.995
SD in Original Scale	10.15	SD in Log Scale	0.699
95% t UCL (Assumes normality)	11.25	95% H-Stat UCL	10.77

DL/2 is not a recommended method, provided for comparisons and historical reasons

Appendix D, Table 20. ProUCL Output - Game Fish Fillet (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 10.43

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:30:56 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	18
Number of Detects	21	Number of Non-Detects	1
Number of Distinct Detects	17	Number of Distinct Non-Detects	1
Minimum Detect	9.34	Minimum Non-Detect	12.1
Maximum Detect	310	Maximum Non-Detect	12.1
Variance Detects	8279	Percent Non-Detects	4.545%
Mean Detects	111.6	SD Detects	90.99
Median Detects	77	CV Detects	0.815
Skewness Detects	0.669	Kurtosis Detects	-0.813
Mean of Logged Detects	4.302	SD of Logged Detects	1.018

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.888	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.18	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	107	KM Standard Error of Mean	19.52
KM SD	89.33	95% KM (BCA) UCL	139.4
95% KM (t) UCL	140.5	95% KM (Percentile Bootstrap) UCL	138.5
95% KM (z) UCL	139.1	95% KM Bootstrap t UCL	145.3
90% KM Chebyshev UCL	165.5	95% KM Chebyshev UCL	192
97.5% KM Chebyshev UCL	228.8	99% KM Chebyshev UCL	301.1

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.472	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.136	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.352	k star (bias corrected MLE)	1.191
Theta hat (MLE)	82.54	Theta star (bias corrected MLE)	93.73
nu hat (MLE)	56.79	nu star (bias corrected)	50.01
Mean (detects)	111.6		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.704	Mean	106.6
Maximum	310	Median	70
SD	91.89	CV	0.862
k hat (MLE)	0.998	k star (bias corrected MLE)	0.892
Theta hat (MLE)	106.8	Theta star (bias corrected MLE)	119.5
nu hat (MLE)	43.91	nu star (bias corrected)	39.25
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (39.25, α)	25.9	Adjusted Chi Square Value (39.25, β)	25.09
95% Gamma Approximate UCL (use when n>=50)	161.5	95% Gamma Adjusted UCL (use when n<50)	166.7

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	107	SD (KM)	89.33
Variance (KM)	7980	SE of Mean (KM)	19.52
k hat (KM)	1.434	k star (KM)	1.268
nu hat (KM)	63.08	nu star (KM)	55.81
theta hat (KM)	74.61	theta star (KM)	84.33
80% gamma percentile (KM)	168.4	90% gamma percentile (KM)	232.2
95% gamma percentile (KM)	294.9	99% gamma percentile (KM)	438

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (55.81, α)	39.64	Adjusted Chi Square Value (55.81, β)	38.62
95% Gamma Approximate KM-UCL (use when n>=50)	150.6	95% Gamma Adjusted KM-UCL (use when n<50)	154.6

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.945	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.137	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	107	Mean in Log Scale	4.209
SD in Original Scale	91.42	SD in Log Scale	1.084
95% t UCL (assumes normality of ROS data)	140.5	95% Percentile Bootstrap UCL	138.6
95% BCA Bootstrap UCL	142.2	95% Bootstrap t UCL	147.6
95% H-UCL (Log ROS)	229.5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.208	KM Geo Mean	67.2
KM SD (logged)	1.062	95% Critical H Value (KM-Log)	2.669
KM Standard Error of Mean (logged)	0.232	95% H-UCL (KM -Log)	219.1
KM SD (logged)	1.062	95% Critical H Value (KM-Log)	2.669
KM Standard Error of Mean (logged)	0.232		

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	106.8	Mean in Log Scale	4.188
SD in Original Scale	91.6	SD in Log Scale	1.127
95% t UCL (Assumes normality)	140.4	95% H-Stat UCL	245.5

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 140.5

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	19
Number of Detects	20	Number of Non-Detects	2
Number of Distinct Detects	18	Number of Distinct Non-Detects	1
Minimum Detect	0.11	Minimum Non-Detect	5.37
Maximum Detect	20.4	Maximum Non-Detect	5.37
Variance Detects	20.66	Percent Non-Detects	9.091%
Mean Detects	1.798	SD Detects	4.545
Median Detects	0.395	CV Detects	2.528
Skewness Detects	4.008	Kurtosis Detects	16.77
Mean of Logged Detects	-0.51	SD of Logged Detects	1.172

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.376	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.905	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.437	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.192	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.709	KM Standard Error of Mean	0.933
KM SD	4.249	95% KM (BCA) UCL	3.382
95% KM (t) UCL	3.315	95% KM (Percentile Bootstrap) UCL	3.406
95% KM (z) UCL	3.244	95% KM Bootstrap t UCL	9.963
90% KM Chebyshev UCL	4.509	95% KM Chebyshev UCL	5.777
97.5% KM Chebyshev UCL	7.538	99% KM Chebyshev UCL	11

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.527	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.796	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.379	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.204	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.568	k star (bias corrected MLE)	0.516
Theta hat (MLE)	3.166	Theta star (bias corrected MLE)	3.485
nu hat (MLE)	22.71	nu star (bias corrected)	20.64
Mean (detects)	1.798		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.705
Maximum	20.4	Median	0.395
SD	4.34	CV	2.545
k hat (MLE)	0.53	k star (bias corrected MLE)	0.488
Theta hat (MLE)	3.216	Theta star (bias corrected MLE)	3.493
nu hat (MLE)	23.33	nu star (bias corrected)	21.48
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (21.48, α)	11.95	Adjusted Chi Square Value (21.48, β)	11.42
95% Gamma Approximate UCL (use when n>=50)	3.065	95% Gamma Adjusted UCL (use when n<50)	3.207

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.709	SD (KM)	4.249
Variance (KM)	18.06	SE of Mean (KM)	0.933
k hat (KM)	0.162	k star (KM)	0.17
nu hat (KM)	7.117	nu star (KM)	7.48
theta hat (KM)	10.57	theta star (KM)	10.05
80% gamma percentile (KM)	2.043	90% gamma percentile (KM)	5.136
95% gamma percentile (KM)	9.162	99% gamma percentile (KM)	20.56

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.48, α)	2.438	Adjusted Chi Square Value (7.48, β)	2.228
95% Gamma Approximate KM-UCL (use when n>=50)	5.244	95% Gamma Adjusted KM-UCL (use when n<50)	5.737

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.757	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.262	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.69	Mean in Log Scale	-0.519
SD in Original Scale	4.338	SD in Log Scale	1.124
95% t UCL (assumes normality of ROS data)	3.281	95% Percentile Bootstrap UCL	3.401
95% BCA Bootstrap UCL	4.658	95% Bootstrap t UCL	10.11
95% H-UCL (Log ROS)	2.203		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.527	KM Geo Mean	0.59
KM SD (logged)	1.119	95% Critical H Value (KM-Log)	2.751
KM Standard Error of Mean (logged)	0.251	95% H-UCL (KM -Log)	2.16
KM SD (logged)	1.119	95% Critical H Value (KM-Log)	2.751
KM Standard Error of Mean (logged)	0.251		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.879	Mean in Log Scale	-0.374
SD in Original Scale	4.331	SD in Log Scale	1.199
95% t UCL (Assumes normality)	3.468	95% H-Stat UCL	2.99

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	5.777

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
Number of Detects	9	Number of Non-Detects	1
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	5.24	Minimum Non-Detect	4.01
Maximum Detect	101	Maximum Non-Detect	4.01
Variance Detects	1622	Percent Non-Detects	10%
Mean Detects	54.42	SD Detects	40.27
Median Detects	78.8	CV Detects	0.74
Skewness Detects	-0.259	Kurtosis Detects	-2.215
Mean of Logged Detects	3.522	SD of Logged Detects	1.219

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.283	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	49.38	KM Standard Error of Mean	13.1
KM SD	39.07	95% KM (BCA) UCL	70.53
95% KM (t) UCL	73.4	95% KM (Percentile Bootstrap) UCL	69.5
95% KM (z) UCL	70.93	95% KM Bootstrap t UCL	74.42
90% KM Chebyshev UCL	88.69	95% KM Chebyshev UCL	106.5
97.5% KM Chebyshev UCL	131.2	99% KM Chebyshev UCL	179.8

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.824	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.74	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.323	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.286	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.192	k star (bias corrected MLE)	0.869
Theta hat (MLE)	45.64	Theta star (bias corrected MLE)	62.63
nu hat (MLE)	21.46	nu star (bias corrected)	15.64
Mean (detects)	54.42		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	5.24	Mean	49.53
Maximum	101	Median	53.3
SD	41	CV	0.828
k hat (MLE)	1.025	k star (bias corrected MLE)	0.784
Theta hat (MLE)	48.34	Theta star (bias corrected MLE)	63.18
nu hat (MLE)	20.49	nu star (bias corrected)	15.68
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (15.68, α)	7.737	Adjusted Chi Square Value (15.68, β)	6.789
95% Gamma Approximate UCL (use when n>=50)	100.4	95% Gamma Adjusted UCL (use when n<50)	114.4

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	49.38	SD (KM)	39.07
Variance (KM)	1526	SE of Mean (KM)	13.1
k hat (KM)	1.598	k star (KM)	1.185
nu hat (KM)	31.95	nu star (KM)	23.7
theta hat (KM)	30.91	theta star (KM)	41.67
80% gamma percentile (KM)	78.28	90% gamma percentile (KM)	109
95% gamma percentile (KM)	139.4	99% gamma percentile (KM)	209

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (23.70, α)	13.62	Adjusted Chi Square Value (23.70, β)	12.31
95% Gamma Approximate KM-UCL (use when n>=50)	85.92	95% Gamma Adjusted KM-UCL (use when n<50)	95.06

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.806	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.311	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	49.19	Mean in Log Scale	3.246
SD in Original Scale	41.41	SD in Log Scale	1.443
95% t UCL (assumes normality of ROS data)	73.2	95% Percentile Bootstrap UCL	69.64
95% BCA Bootstrap UCL	70.37	95% Bootstrap t UCL	72.51
95% H-UCL (Log ROS)	516.5		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.309	KM Geo Mean	27.35
KM SD (logged)	1.264	95% Critical H Value (KM-Log)	3.67
KM Standard Error of Mean (logged)	0.424	95% H-UCL (KM -Log)	285.4
KM SD (logged)	1.264	95% Critical H Value (KM-Log)	3.67
KM Standard Error of Mean (logged)	0.424		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	49.18	Mean in Log Scale	3.239
SD in Original Scale	41.43	SD in Log Scale	1.456
95% t UCL (Assumes normality)	73.2	95% H-Stat UCL	539.4

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 106.5

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	5
Number of Detects	2	Number of Non-Detects	8
Number of Distinct Detects	2	Number of Distinct Non-Detects	3

Minimum Detect	0.19	Minimum Non-Detect	0.01
Maximum Detect	0.38	Maximum Non-Detect	0.29
Variance Detects	0.0181	Percent Non-Detects	80%
Mean Detects	0.285	SD Detects	0.134
Median Detects	0.285	CV Detects	0.471
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-1.314	SD of Logged Detects	0.49

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0673	KM Standard Error of Mean	0.0538
KM SD	0.119	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.166	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.156	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.229	95% KM Chebyshev UCL	0.302
97.5% KM Chebyshev UCL	0.403	99% KM Chebyshev UCL	0.602

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	8.653	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.0329	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	34.61	nu star (bias corrected)	N/A
Mean (detects)	0.285		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0673	SD (KM)	0.119
Variance (KM)	0.0141	SE of Mean (KM)	0.0538
k hat (KM)	0.322	k star (KM)	0.292
nu hat (KM)	6.434	nu star (KM)	5.837
theta hat (KM)	0.209	theta star (KM)	0.23
80% gamma percentile (KM)	0.102	90% gamma percentile (KM)	0.199
95% gamma percentile (KM)	0.31	99% gamma percentile (KM)	0.601

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0267
Approximate Chi Square Value (5.84, α)	1.557	Adjusted Chi Square Value (5.84, β)	1.207
95% Gamma Approximate KM-UCL (use when n>=50)	0.252	95% Gamma Adjusted KM-UCL (use when n<50)	0.325

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.099	Mean in Log Scale	-2.724
SD in Original Scale	0.11	SD in Log Scale	0.911
95% t UCL (assumes normality of ROS data)	0.163	95% Percentile Bootstrap UCL	0.163
95% BCA Bootstrap UCL	0.177	95% Bootstrap t UCL	0.302
95% H-UCL (Log ROS)	0.241		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.91	KM Geo Mean	0.02
KM SD (logged)	1.347	95% Critical H Value (KM-Log)	3.857
KM Standard Error of Mean (logged)	0.62	95% H-UCL (KM -Log)	0.281
KM SD (logged)	1.347	95% Critical H Value (KM-Log)	3.857
KM Standard Error of Mean (logged)	0.62		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.08	Mean in Log Scale	-3.925
SD in Original Scale	0.125	SD in Log Scale	1.832
95% t UCL (Assumes normality)	0.152	95% H-Stat UCL	2.23

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.166	KM H-UCL	0.281
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	19
Number of Detects	19	Number of Non-Detects	3
Number of Distinct Detects	16	Number of Distinct Non-Detects	3
Minimum Detect	0.042	Minimum Non-Detect	0.56
Maximum Detect	1.6	Maximum Non-Detect	1.54
Variance Detects	0.2	Percent Non-Detects	13.64%
Mean Detects	0.421	SD Detects	0.448
Median Detects	0.29	CV Detects	1.063
Skewness Detects	1.61	Kurtosis Detects	1.751
Mean of Logged Detects	-1.351	SD of Logged Detects	1.019

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.77	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.282	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data Not Normal at 5% Significance Level

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.397	KM Standard Error of Mean	0.0933
KM SD	0.418	95% KM (BCA) UCL	0.552
95% KM (t) UCL	0.557	95% KM (Percentile Bootstrap) UCL	0.558
95% KM (z) UCL	0.55	95% KM Bootstrap t UCL	0.631
90% KM Chebyshev UCL	0.677	95% KM Chebyshev UCL	0.804
97.5% KM Chebyshev UCL	0.979	99% KM Chebyshev UCL	1.325

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.584	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.765	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.183	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.204	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.166	k star (bias corrected MLE)	1.017
Theta hat (MLE)	0.361	Theta star (bias corrected MLE)	0.414
nu hat (MLE)	44.29	nu star (bias corrected)	38.63
Mean (detects)	0.421		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.042	Mean	0.392
Maximum	1.6	Median	0.24
SD	0.421	CV	1.075
k hat (MLE)	1.258	k star (bias corrected MLE)	1.117
Theta hat (MLE)	0.312	Theta star (bias corrected MLE)	0.351
nu hat (MLE)	55.37	nu star (bias corrected)	49.15
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (49.15, α)	34.06	Adjusted Chi Square Value (49.15, β)	33.12
95% Gamma Approximate UCL (use when n>=50)	0.566	95% Gamma Adjusted UCL (use when n<50)	0.582

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.397	SD (KM)	0.418
Variance (KM)	0.175	SE of Mean (KM)	0.0933
k hat (KM)	0.902	k star (KM)	0.809
nu hat (KM)	39.67	nu star (KM)	35.6
theta hat (KM)	0.44	theta star (KM)	0.491
80% gamma percentile (KM)	0.648	90% gamma percentile (KM)	0.962
95% gamma percentile (KM)	1.282	99% gamma percentile (KM)	2.037

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (35.60, α)	22.94	Adjusted Chi Square Value (35.60, β)	22.19
95% Gamma Approximate KM-UCL (use when n>=50)	0.616	95% Gamma Adjusted KM-UCL (use when n<50)	0.637

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.968	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.125	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.39	Mean in Log Scale	-1.392
SD in Original Scale	0.422	SD in Log Scale	0.95
95% t UCL (assumes normality of ROS data)	0.545	95% Percentile Bootstrap UCL	0.537
95% BCA Bootstrap UCL	0.58	95% Bootstrap t UCL	0.637
95% H-UCL (Log ROS)	0.658		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.401	KM Geo Mean	0.246
KM SD (logged)	0.972	95% Critical H Value (KM-Log)	2.544
KM Standard Error of Mean (logged)	0.222	95% H-UCL (KM -Log)	0.677
KM SD (logged)	0.972	95% Critical H Value (KM-Log)	2.544
KM Standard Error of Mean (logged)	0.222		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.425	Mean in Log Scale	-1.293
SD in Original Scale	0.424	SD in Log Scale	0.972
95% t UCL (Assumes normality)	0.58	95% H-Stat UCL	0.755

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.637	95% GROS Adjusted Gamma UCL	0.582

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	21
Number of Detects	18	Number of Non-Detects	4
Number of Distinct Detects	17	Number of Distinct Non-Detects	4
Minimum Detect	0.066	Minimum Non-Detect	1.23
Maximum Detect	0.87	Maximum Non-Detect	3.4
Variance Detects	0.0718	Percent Non-Detects	18.18%
Mean Detects	0.405	SD Detects	0.268
Median Detects	0.295	CV Detects	0.662
Skewness Detects	0.621	Kurtosis Detects	-1.112
Mean of Logged Detects	-1.145	SD of Logged Detects	0.758

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.883	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.207	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.405	KM Standard Error of Mean	0.0632
KM SD	0.26	95% KM (BCA) UCL	0.519
95% KM (t) UCL	0.513	95% KM (Percentile Bootstrap) UCL	0.508
95% KM (z) UCL	0.509	95% KM Bootstrap t UCL	0.519
90% KM Chebyshev UCL	0.594	95% KM Chebyshev UCL	0.68
97.5% KM Chebyshev UCL	0.799	99% KM Chebyshev UCL	1.033

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.437	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.135	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.206	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.235	k star (bias corrected MLE)	1.899
Theta hat (MLE)	0.181	Theta star (bias corrected MLE)	0.213
nu hat (MLE)	80.46	nu star (bias corrected)	68.38
Mean (detects)	0.405		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.066	Mean	0.396
Maximum	0.87	Median	0.353
SD	0.242	CV	0.611
k hat (MLE)	2.685	k star (bias corrected MLE)	2.349
Theta hat (MLE)	0.147	Theta star (bias corrected MLE)	0.168
nu hat (MLE)	118.1	nu star (bias corrected)	103.3
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (103.35, α)	80.89	Adjusted Chi Square Value (103.35, β)	79.41
95% Gamma Approximate UCL (use when n>=50)	0.506	95% Gamma Adjusted UCL (use when n<50)	0.515

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.405	SD (KM)	0.26
Variance (KM)	0.0678	SE of Mean (KM)	0.0632
k hat (KM)	2.413	k star (KM)	2.115
nu hat (KM)	106.2	nu star (KM)	93.04
theta hat (KM)	0.168	theta star (KM)	0.191
80% gamma percentile (KM)	0.602	90% gamma percentile (KM)	0.777
95% gamma percentile (KM)	0.943	99% gamma percentile (KM)	1.311

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (93.04, α)	71.8	Adjusted Chi Square Value (93.04, β)	70.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.524	95% Gamma Adjusted KM-UCL (use when n<50)	0.535

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.132	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.389	Mean in Log Scale	-1.145
SD in Original Scale	0.244	SD in Log Scale	0.682
95% t UCL (assumes normality of ROS data)	0.478	95% Percentile Bootstrap UCL	0.469
95% BCA Bootstrap UCL	0.484	95% Bootstrap t UCL	0.488
95% H-UCL (Log ROS)	0.555		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.145	KM Geo Mean	0.318
KM SD (logged)	0.736	95% Critical H Value (KM-Log)	2.245
KM Standard Error of Mean (logged)	0.179	95% H-UCL (KM -Log)	0.599
KM SD (logged)	0.736	95% Critical H Value (KM-Log)	2.245
KM Standard Error of Mean (logged)	0.179		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.495	Mean in Log Scale	-0.974
SD in Original Scale	0.37	SD in Log Scale	0.798
95% t UCL (Assumes normality)	0.631	95% H-Stat UCL	0.777

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.535	95% GROS Adjusted Gamma UCL	0.515

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	7
Number of Detects	4	Number of Non-Detects	6
Number of Distinct Detects	3	Number of Distinct Non-Detects	4

Minimum Detect	0.05	Minimum Non-Detect	0.04
Maximum Detect	0.08	Maximum Non-Detect	1.89
Variance Detects	2.2500E-4	Percent Non-Detects	60%
Mean Detects	0.0625	SD Detects	0.015
Median Detects	0.06	CV Detects	0.24
Skewness Detects	0.37	Kurtosis Detects	-3.901
Mean of Logged Detects	-2.794	SD of Logged Detects	0.239

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.851	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.298	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.055	KM Standard Error of Mean	0.00707
KM SD	0.015	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.068	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0666	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0762	95% KM Chebyshev UCL	0.0858
97.5% KM Chebyshev UCL	0.0992	99% KM Chebyshev UCL	0.125

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.484	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.657	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.334	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.394	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	23.39	k star (bias corrected MLE)	6.015
Theta hat (MLE)	0.00267	Theta star (bias corrected MLE)	0.0104
nu hat (MLE)	187.2	nu star (bias corrected)	48.12
Mean (detects)	0.0625		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0202	Mean	0.0499
Maximum	0.08	Median	0.0497
SD	0.0177	CV	0.355
k hat (MLE)	7.714	k star (bias corrected MLE)	5.467
Theta hat (MLE)	0.00646	Theta star (bias corrected MLE)	0.00912
nu hat (MLE)	154.3	nu star (bias corrected)	109.3
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (109.34, α)	86.2	Adjusted Chi Square Value (109.34, β)	82.64
95% Gamma Approximate UCL (use when n>=50)	0.0632	95% Gamma Adjusted UCL (use when n<50)	N/A

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.055	SD (KM)	0.015
Variance (KM)	2.2500E-4	SE of Mean (KM)	0.00707
k hat (KM)	13.44	k star (KM)	9.478
nu hat (KM)	268.9	nu star (KM)	189.6
theta hat (KM)	0.00409	theta star (KM)	0.0058
80% gamma percentile (KM)	0.0692	90% gamma percentile (KM)	0.0788
95% gamma percentile (KM)	0.0873	99% gamma percentile (KM)	0.105

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (189.56, α)	158.7	Adjusted Chi Square Value (189.56, β)	153.8
95% Gamma Approximate KM-UCL (use when n>=50)	0.0657	95% Gamma Adjusted KM-UCL (use when n<50)	0.0678

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.839	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.3	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0514	Mean in Log Scale	-3.008
SD in Original Scale	0.0153	SD in Log Scale	0.303
95% t UCL (assumes normality of ROS data)	0.0603	95% Percentile Bootstrap UCL	0.059
95% BCA Bootstrap UCL	0.0598	95% Bootstrap t UCL	0.062
95% H-UCL (Log ROS)	0.0632		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.936	KM Geo Mean	0.0531
KM SD (logged)	0.262	95% Critical H Value (KM-Log)	1.939
KM Standard Error of Mean (logged)	0.124	95% H-UCL (KM -Log)	0.0651
KM SD (logged)	0.262	95% Critical H Value (KM-Log)	1.939
KM Standard Error of Mean (logged)	0.124		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.228	Mean in Log Scale	-2.224
SD in Original Scale	0.289	SD in Log Scale	1.331
95% t UCL (Assumes normality)	0.395	95% H-Stat UCL	1.427

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.068

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Copper (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	21
Number of Detects	21	Number of Non-Detects	1
Number of Distinct Detects	20	Number of Distinct Non-Detects	1
Minimum Detect	0.44	Minimum Non-Detect	3.52
Maximum Detect	6.55	Maximum Non-Detect	3.52
Variance Detects	2.467	Percent Non-Detects	4.545%
Mean Detects	2.569	SD Detects	1.571
Median Detects	1.8	CV Detects	0.611
Skewness Detects	0.677	Kurtosis Detects	0.176
Mean of Logged Detects	0.732	SD of Logged Detects	0.714

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data Not Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.53	KM Standard Error of Mean	0.335
KM SD	1.521	95% KM (BCA) UCL	3.105
95% KM (t) UCL	3.107	95% KM (Percentile Bootstrap) UCL	3.092
95% KM (z) UCL	3.081	95% KM Bootstrap t UCL	3.188
90% KM Chebyshev UCL	3.536	95% KM Chebyshev UCL	3.991
97.5% KM Chebyshev UCL	4.623	99% KM Chebyshev UCL	5.865

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.596	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.194	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.191	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.518	k star (bias corrected MLE)	2.19
Theta hat (MLE)	1.02	Theta star (bias corrected MLE)	1.173
nu hat (MLE)	105.8	nu star (bias corrected)	91.99
Mean (detects)	2.569		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.44	Mean	2.528
Maximum	6.55	Median	1.76
SD	1.545	CV	0.611
k hat (MLE)	2.588	k star (bias corrected MLE)	2.266
Theta hat (MLE)	0.977	Theta star (bias corrected MLE)	1.116
nu hat (MLE)	113.9	nu star (bias corrected)	99.69
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (99.69, α)	77.66	Adjusted Chi Square Value (99.69, β)	76.21
95% Gamma Approximate UCL (use when n>=50)	3.245	95% Gamma Adjusted UCL (use when n<50)	3.307

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.53	SD (KM)	1.521
Variance (KM)	2.314	SE of Mean (KM)	0.335
k hat (KM)	2.766	k star (KM)	2.419
nu hat (KM)	121.7	nu star (KM)	106.4
theta hat (KM)	0.915	theta star (KM)	1.046
80% gamma percentile (KM)	3.703	90% gamma percentile (KM)	4.708
95% gamma percentile (KM)	5.657	99% gamma percentile (KM)	7.738

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (106.45, α)	83.64	Adjusted Chi Square Value (106.45, β)	82.13
95% Gamma Approximate KM-UCL (use when n>=50)	3.22	95% Gamma Adjusted KM-UCL (use when n<50)	3.279

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.52	Mean in Log Scale	0.717
SD in Original Scale	1.55	SD in Log Scale	0.7
95% t UCL (assumes normality of ROS data)	3.089	95% Percentile Bootstrap UCL	3.055
95% BCA Bootstrap UCL	3.184	95% Bootstrap t UCL	3.145
95% H-UCL (Log ROS)	3.666		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.716	KM Geo Mean	2.046
KM SD (logged)	0.696	95% Critical H Value (KM-Log)	2.198
KM Standard Error of Mean (logged)	0.155	95% H-UCL (KM -Log)	3.64
KM SD (logged)	0.696	95% Critical H Value (KM-Log)	2.198
KM Standard Error of Mean (logged)	0.155		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.532	Mean in Log Scale	0.724
SD in Original Scale	1.542	SD in Log Scale	0.698
95% t UCL (Assumes normality)	3.098	95% H-Stat UCL	3.68

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 3.107

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	29.2	Mean	137.3
Maximum	300	Median	140
SD	82.05	Std. Error of Mean	17.49
Coefficient of Variation	0.598	Skewness	0.435

Normal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	167.4	95% Adjusted-CLT UCL (Chen-1995)	167.8
		95% Modified-t UCL (Johnson-1978)	167.6

Gamma GOF Test

A-D Test Statistic	0.403	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.138	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.187	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.446	k star (bias corrected MLE)	2.143
Theta hat (MLE)	56.12	Theta star (bias corrected MLE)	64.07
nu hat (MLE)	107.6	nu star (bias corrected)	94.27
MLE Mean (bias corrected)	137.3	MLE Sd (bias corrected)	93.78
		Approximate Chi Square Value (0.05)	72.88
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	71.48

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	177.6	95% Adjusted Gamma UCL (use when n<50)	181

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.918	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.162	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.374	Mean of logged Data	4.704
Maximum of Logged Data	5.704	SD of logged Data	0.734

Assuming Lognormal Distribution

95% H-UCL	206.9	90% Chebyshev (MVUE) UCL	214.3
95% Chebyshev (MVUE) UCL	246.9	97.5% Chebyshev (MVUE) UCL	292.1
99% Chebyshev (MVUE) UCL	381		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	166	95% Jackknife UCL	167.4
95% Standard Bootstrap UCL	166.1	95% Bootstrap-t UCL	169.6
95% Hall's Bootstrap UCL	168.5	95% Percentile Bootstrap UCL	166.1
95% BCA Bootstrap UCL	166.6		
90% Chebyshev(Mean, Sd) UCL	189.7	95% Chebyshev(Mean, Sd) UCL	213.5
97.5% Chebyshev(Mean, Sd) UCL	246.5	99% Chebyshev(Mean, Sd) UCL	311.3

Suggested UCL to Use

95% Student's-t UCL 167.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Number of Detects	19	Number of Non-Detects	3
Number of Distinct Detects	19	Number of Distinct Non-Detects	3
Minimum Detect	0.23	Minimum Non-Detect	0.24
Maximum Detect	20.8	Maximum Non-Detect	4.67
Variance Detects	23.26	Percent Non-Detects	13.64%
Mean Detects	2.002	SD Detects	4.822
Median Detects	0.59	CV Detects	2.409
Skewness Detects	3.735	Kurtosis Detects	14.48
Mean of Logged Detects	-0.335	SD of Logged Detects	1.13

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.391	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.453	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.79	KM Standard Error of Mean	0.963
KM SD	4.396	95% KM (BCA) UCL	3.631
95% KM (t) UCL	3.447	95% KM (Percentile Bootstrap) UCL	3.433
95% KM (z) UCL	3.374	95% KM Bootstrap t UCL	21.42
90% KM Chebyshev UCL	4.679	95% KM Chebyshev UCL	5.988
97.5% KM Chebyshev UCL	7.805	99% KM Chebyshev UCL	11.37

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.141	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.793	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.355	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.208	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.6	k star (bias corrected MLE)	0.541
Theta hat (MLE)	3.335	Theta star (bias corrected MLE)	3.703
nu hat (MLE)	22.82	nu star (bias corrected)	20.55
Mean (detects)	2.002		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.73
Maximum	20.8	Median	0.55
SD	4.519	CV	2.612
k hat (MLE)	0.442	k star (bias corrected MLE)	0.412
Theta hat (MLE)	3.916	Theta star (bias corrected MLE)	4.201
nu hat (MLE)	19.44	nu star (bias corrected)	18.13
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (18.13, α)	9.482	Adjusted Chi Square Value (18.13, β)	9.017
95% Gamma Approximate UCL (use when n>=50)	3.308	95% Gamma Adjusted UCL (use when n<50)	3.479

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.79	SD (KM)	4.396
Variance (KM)	19.32	SE of Mean (KM)	0.963
k hat (KM)	0.166	k star (KM)	0.174
nu hat (KM)	7.299	nu star (KM)	7.637
theta hat (KM)	10.79	theta star (KM)	10.32
80% gamma percentile (KM)	2.17	90% gamma percentile (KM)	5.388
95% gamma percentile (KM)	9.552	99% gamma percentile (KM)	21.3

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.64, α)	2.526	Adjusted Chi Square Value (7.64, β)	2.312
95% Gamma Approximate KM-UCL (use when n>=50)	5.411	95% Gamma Adjusted KM-UCL (use when n<50)	5.913

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.775	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.235	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.784	Mean in Log Scale	-0.447
SD in Original Scale	4.501	SD in Log Scale	1.127
95% t UCL (assumes normality of ROS data)	3.435	95% Percentile Bootstrap UCL	3.597
95% BCA Bootstrap UCL	4.591	95% Bootstrap t UCL	23.19
95% H-UCL (Log ROS)	2.384		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.421	KM Geo Mean	0.656
KM SD (logged)	1.064	95% Critical H Value (KM-Log)	2.673
KM Standard Error of Mean (logged)	0.236	95% H-UCL (KM -Log)	2.152
KM SD (logged)	1.064	95% Critical H Value (KM-Log)	2.673
KM Standard Error of Mean (logged)	0.236		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.944	Mean in Log Scale	-0.31
SD in Original Scale	4.484	SD in Log Scale	1.173
95% t UCL (Assumes normality)	3.589	95% H-Stat UCL	3.011

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	5.988

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	2.36	Mean	396
Maximum	1540	Median	29
SD	616.3	Std. Error of Mean	131.4
Coefficient of Variation	1.556	Skewness	1.283

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.635	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.331	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	622.1	95% Adjusted-CLT UCL (Chen-1995)	650.5
		95% Modified-t UCL (Johnson-1978)	628.1

Gamma GOF Test

A-D Test Statistic	1.778	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.835	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.269	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.2	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.356	k star (bias corrected MLE)	0.338
Theta hat (MLE)	1111	Theta star (bias corrected MLE)	1171
nu hat (MLE)	15.68	nu star (bias corrected)	14.88
MLE Mean (bias corrected)	396	MLE Sd (bias corrected)	681.1
		Approximate Chi Square Value (0.05)	7.175
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	6.778

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	821.1	95% Adjusted Gamma UCL (use when n<50)	869.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.878	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.194	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.184	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.859	Mean of logged Data	4.1
Maximum of Logged Data	7.34	SD of logged Data	2.202

Assuming Lognormal Distribution

95% H-UCL	6046	90% Chebyshev (MVUE) UCL	1408
95% Chebyshev (MVUE) UCL	1817	97.5% Chebyshev (MVUE) UCL	2384
99% Chebyshev (MVUE) UCL	3499		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	612.1	95% Jackknife UCL	622.1
95% Standard Bootstrap UCL	598.8	95% Bootstrap-t UCL	681
95% Hall's Bootstrap UCL	594.9	95% Percentile Bootstrap UCL	618.3
95% BCA Bootstrap UCL	653.9		
90% Chebyshev(Mean, Sd) UCL	790.2	95% Chebyshev(Mean, Sd) UCL	968.7
97.5% Chebyshev(Mean, Sd) UCL	1217	99% Chebyshev(Mean, Sd) UCL	1703

Suggested UCL to Use

97.5% Chebyshev (Mean, Sd) UCL	1217

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.00285	Mean	0.00888
Maximum	0.0181	Median	0.00777
SD	0.00537	Std. Error of Mean	0.0017
Coefficient of Variation	0.605	Skewness	0.413

Normal GOF Test

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.156	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.012	95% Adjusted-CLT UCL (Chen-1995)	0.0119
		95% Modified-t UCL (Johnson-1978)	0.012

Gamma GOF Test

A-D Test Statistic	0.404	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.733	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.192	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.269	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.756	k star (bias corrected MLE)	1.996
Theta hat (MLE)	0.00322	Theta star (bias corrected MLE)	0.00445
nu hat (MLE)	55.12	nu star (bias corrected)	39.92
MLE Mean (bias corrected)	0.00888	MLE Sd (bias corrected)	0.00628
		Approximate Chi Square Value (0.05)	26.44
Adjusted Level of Significance	0.0267	Adjusted Chi Square Value	24.55

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0134	95% Adjusted Gamma UCL (use when n<50)	0.0144

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.907	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.187	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.262	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.86	Mean of logged Data	-4.917
Maximum of Logged Data	-4.012	SD of logged Data	0.682

Assuming Lognormal Distribution

95% H-UCL	0.0163	90% Chebyshev (MVUE) UCL	0.015
95% Chebyshev (MVUE) UCL	0.0177	97.5% Chebyshev (MVUE) UCL	0.0215
99% Chebyshev (MVUE) UCL	0.0289		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0117	95% Jackknife UCL	0.012
95% Standard Bootstrap UCL	0.0115	95% Bootstrap-t UCL	0.0121
95% Hall's Bootstrap UCL	0.0117	95% Percentile Bootstrap UCL	0.0116
95% BCA Bootstrap UCL	0.0116		
90% Chebyshev(Mean, Sd) UCL	0.014	95% Chebyshev(Mean, Sd) UCL	0.0163
97.5% Chebyshev(Mean, Sd) UCL	0.0195	99% Chebyshev(Mean, Sd) UCL	0.0258

Suggested UCL to Use

95% Student's-t UCL 0.012

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	20
Number of Detects	18	Number of Non-Detects	4
Number of Distinct Detects	16	Number of Distinct Non-Detects	4
Minimum Detect	0.1	Minimum Non-Detect	1.4
Maximum Detect	0.61	Maximum Non-Detect	3.89
Variance Detects	0.0255	Percent Non-Detects	18.18%
Mean Detects	0.324	SD Detects	0.16
Median Detects	0.325	CV Detects	0.492
Skewness Detects	0.218	Kurtosis Detects	-1.278
Mean of Logged Detects	-1.259	SD of Logged Detects	0.554

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.324	KM Standard Error of Mean	0.0377
KM SD	0.155	95% KM (BCA) UCL	0.386
95% KM (t) UCL	0.389	95% KM (Percentile Bootstrap) UCL	0.385
95% KM (z) UCL	0.386	95% KM Bootstrap t UCL	0.39
90% KM Chebyshev UCL	0.437	95% KM Chebyshev UCL	0.489
97.5% KM Chebyshev UCL	0.56	99% KM Chebyshev UCL	0.699

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.461	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.168	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.205	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.917	k star (bias corrected MLE)	3.302
Theta hat (MLE)	0.0828	Theta star (bias corrected MLE)	0.0983
nu hat (MLE)	141	nu star (bias corrected)	118.9
Mean (detects)	0.324		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.1	Mean	0.32
Maximum	0.61	Median	0.302
SD	0.144	CV	0.449
k hat (MLE)	4.738	k star (bias corrected MLE)	4.123
Theta hat (MLE)	0.0676	Theta star (bias corrected MLE)	0.0777
nu hat (MLE)	208.5	nu star (bias corrected)	181.4
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (181.39, α)	151.2	Adjusted Chi Square Value (181.39, β)	149.2
95% Gamma Approximate UCL (use when n>=50)	0.384	95% Gamma Adjusted UCL (use when n<50)	0.39

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.324	SD (KM)	0.155
Variance (KM)	0.0241	SE of Mean (KM)	0.0377
k hat (KM)	4.367	k star (KM)	3.802
nu hat (KM)	192.2	nu star (KM)	167.3
theta hat (KM)	0.0743	theta star (KM)	0.0853
80% gamma percentile (KM)	0.45	90% gamma percentile (KM)	0.548
95% gamma percentile (KM)	0.637	99% gamma percentile (KM)	0.83

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (167.29, α)	138.4	Adjusted Chi Square Value (167.29, β)	136.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.392	95% Gamma Adjusted KM-UCL (use when n<50)	0.398

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.183	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.317	Mean in Log Scale	-1.259
SD in Original Scale	0.145	SD in Log Scale	0.499
95% t UCL (assumes normality of ROS data)	0.37	95% Percentile Bootstrap UCL	0.37
95% BCA Bootstrap UCL	0.372	95% Bootstrap t UCL	0.373
95% H-UCL (Log ROS)	0.4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.259	KM Geo Mean	0.284
KM SD (logged)	0.539	95% Critical H Value (KM-Log)	2.033
KM Standard Error of Mean (logged)	0.131	95% H-UCL (KM -Log)	0.417
KM SD (logged)	0.539	95% Critical H Value (KM-Log)	2.033
KM Standard Error of Mean (logged)	0.131		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.451	Mean in Log Scale	-1.045
SD in Original Scale	0.388	SD in Log Scale	0.706
95% t UCL (Assumes normality)	0.594	95% H-Stat UCL	0.634

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.389

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	17
Number of Detects	13	Number of Non-Detects	9
Number of Distinct Detects	12	Number of Distinct Non-Detects	5

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum Detect	0.17	Minimum Non-Detect	0.73
Maximum Detect	32.6	Maximum Non-Detect	38.8
Variance Detects	79.74	Percent Non-Detects	40.91%
Mean Detects	2.882	SD Detects	8.93
Median Detects	0.46	CV Detects	3.099
Skewness Detects	3.605	Kurtosis Detects	13
Mean of Logged Detects	-0.608	SD of Logged Detects	1.271

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.322	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.525	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.938	KM Standard Error of Mean	1.558
KM SD	6.857	95% KM (BCA) UCL	5.054
95% KM (t) UCL	4.618	95% KM (Percentile Bootstrap) UCL	4.813
95% KM (z) UCL	4.5	95% KM Bootstrap t UCL	103.2
90% KM Chebyshev UCL	6.611	95% KM Chebyshev UCL	8.727
97.5% KM Chebyshev UCL	11.67	99% KM Chebyshev UCL	17.44

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.72	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.811	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.521	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.253	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.396	k star (bias corrected MLE)	0.356
Theta hat (MLE)	7.285	Theta star (bias corrected MLE)	8.105
nu hat (MLE)	10.28	nu star (bias corrected)	9.244
Mean (detects)	2.882		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.987
Maximum	32.6	Median	0.371
SD	6.9	CV	3.472
k hat (MLE)	0.304	k star (bias corrected MLE)	0.293
Theta hat (MLE)	6.534	Theta star (bias corrected MLE)	6.783
nu hat (MLE)	13.38	nu star (bias corrected)	12.89
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (12.89, α)	5.818	Adjusted Chi Square Value (12.89, β)	5.466
95% Gamma Approximate UCL (use when n>=50)	4.402	95% Gamma Adjusted UCL (use when n<50)	4.686

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.938	SD (KM)	6.857
Variance (KM)	47.02	SE of Mean (KM)	1.558
k hat (KM)	0.0799	k star (KM)	0.0993
nu hat (KM)	3.515	nu star (KM)	4.369
theta hat (KM)	24.26	theta star (KM)	19.52
80% gamma percentile (KM)	1.331	90% gamma percentile (KM)	5.143
95% gamma percentile (KM)	11.25	99% gamma percentile (KM)	30.9

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (4.37, α)	0.873	Adjusted Chi Square Value (4.37, β)	0.766
95% Gamma Approximate KM-UCL (use when n>=50)	9.703	95% Gamma Adjusted KM-UCL (use when n<50)	11.06

95% Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50)

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.548	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.409	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.234	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.917	Mean in Log Scale	-0.665
SD in Original Scale	6.856	SD in Log Scale	1.008
95% t UCL (assumes normality of ROS data)	4.432	95% Percentile Bootstrap UCL	4.832
95% BCA Bootstrap UCL	7.747	95% Bootstrap t UCL	83.14
95% H-UCL (Log ROS)	1.511		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.738	KM Geo Mean	0.478
KM SD (logged)	0.995	95% Critical H Value (KM-Log)	2.576
KM Standard Error of Mean (logged)	0.233	95% H-UCL (KM -Log)	1.372
KM SD (logged)	0.995	95% Critical H Value (KM-Log)	2.576
KM Standard Error of Mean (logged)	0.233		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.333	Mean in Log Scale	-0.319
SD in Original Scale	7.866	SD in Log Scale	1.455
95% t UCL (Assumes normality)	6.218	95% H-Stat UCL	5.917

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	8.727

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Silica (as SIO2) (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	140	Mean	527.5
Maximum	780	Median	555
SD	204.7	Std. Error of Mean	59.09
Coefficient of Variation	0.388	Skewness	-0.489

Normal GOF Test

Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	633.6	95% Adjusted-CLT UCL (Chen-1995)	615.8
		95% Modified-t UCL (Johnson-1978)	632.2

Gamma GOF Test

A-D Test Statistic	0.436	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.732	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.187	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.246	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.367	k star (bias corrected MLE)	4.081
Theta hat (MLE)	98.28	Theta star (bias corrected MLE)	129.3
nu hat (MLE)	128.8	nu star (bias corrected)	97.94
MLE Mean (bias corrected)	527.5	MLE Sd (bias corrected)	261.1
		Approximate Chi Square Value (0.05)	76.12
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	73.18

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	678.8	95% Adjusted Gamma UCL (use when n<50)	706

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.184	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.942	Mean of logged Data	6.172
Maximum of Logged Data	6.659	SD of logged Data	0.505

Assuming Lognormal Distribution

95% H-UCL	755	90% Chebyshev (MVUE) UCL	779.2
95% Chebyshev (MVUE) UCL	888.3	97.5% Chebyshev (MVUE) UCL	1040
99% Chebyshev (MVUE) UCL	1338		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	624.7	95% Jackknife UCL	633.6
95% Standard Bootstrap UCL	618	95% Bootstrap-t UCL	624.6
95% Hall's Bootstrap UCL	620.2	95% Percentile Bootstrap UCL	616.7
95% BCA Bootstrap UCL	608.3		
90% Chebyshev(Mean, Sd) UCL	704.8	95% Chebyshev(Mean, Sd) UCL	785
97.5% Chebyshev(Mean, Sd) UCL	896.5	99% Chebyshev(Mean, Sd) UCL	1115

Suggested UCL to Use

95% Student's-t UCL 633.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Silver (mg/kg)

General Statistics

Total Number of Observations	10	Number of Distinct Observations	8
Number of Detects	6	Number of Non-Detects	4
Number of Distinct Detects	5	Number of Distinct Non-Detects	3
Minimum Detect	0.22	Minimum Non-Detect	2.89
Maximum Detect	0.72	Maximum Non-Detect	8.02
Variance Detects	0.0372	Percent Non-Detects	40%
Mean Detects	0.598	SD Detects	0.193
Median Detects	0.69	CV Detects	0.322
Skewness Detects	-2.078	Kurtosis Detects	4.346
Mean of Logged Detects	-0.584	SD of Logged Detects	0.463

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.696	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.331	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.598	KM Standard Error of Mean	0.0788
KM SD	0.176	95% KM (BCA) UCL	0.695
95% KM (t) UCL	0.743	95% KM (Percentile Bootstrap) UCL	0.7
95% KM (z) UCL	0.728	95% KM Bootstrap t UCL	0.703
90% KM Chebyshev UCL	0.835	95% KM Chebyshev UCL	0.942
97.5% KM Chebyshev UCL	1.09	99% KM Chebyshev UCL	1.382

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.116	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.698	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.349	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.333	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.27	k star (bias corrected MLE)	3.746
Theta hat (MLE)	0.0823	Theta star (bias corrected MLE)	0.16
nu hat (MLE)	87.24	nu star (bias corrected)	44.95
Mean (detects)	0.598		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.22	Mean	0.594
Maximum	0.72	Median	0.63
SD	0.149	CV	0.251
k hat (MLE)	11.47	k star (bias corrected MLE)	8.096
Theta hat (MLE)	0.0518	Theta star (bias corrected MLE)	0.0734
nu hat (MLE)	229.4	nu star (bias corrected)	161.9
Adjusted Level of Significance (β)	0.0267		
Approximate Chi Square Value (161.93, α)	133.5	Adjusted Chi Square Value (161.93, β)	129
95% Gamma Approximate UCL (use when n>=50)	0.721	95% Gamma Adjusted UCL (use when n<50)	0.746

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.598	SD (KM)	0.176
Variance (KM)	0.031	SE of Mean (KM)	0.0788
k hat (KM)	11.54	k star (KM)	8.147
nu hat (KM)	230.9	nu star (KM)	162.9
theta hat (KM)	0.0518	theta star (KM)	0.0734
80% gamma percentile (KM)	0.764	90% gamma percentile (KM)	0.878
95% gamma percentile (KM)	0.98	99% gamma percentile (KM)	1.19

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (162.94, α)	134.4	Adjusted Chi Square Value (162.94, β)	129.9
95% Gamma Approximate KM-UCL (use when n>=50)	0.725	95% Gamma Adjusted KM-UCL (use when n<50)	0.75

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.63	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.352	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.584	Mean in Log Scale	-0.584
SD in Original Scale	0.154	SD in Log Scale	0.358
95% t UCL (assumes normality of ROS data)	0.674	95% Percentile Bootstrap UCL	0.655
95% BCA Bootstrap UCL	0.641	95% Bootstrap t UCL	0.652
95% H-UCL (Log ROS)	0.759		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.584	KM Geo Mean	0.558
KM SD (logged)	0.423	95% Critical H Value (KM-Log)	2.117
KM Standard Error of Mean (logged)	0.189	95% H-UCL (KM -Log)	0.822
KM SD (logged)	0.423	95% Critical H Value (KM-Log)	2.117
KM Standard Error of Mean (logged)	0.189		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.204	Mean in Log Scale	-0.0943
SD in Original Scale	1.08	SD in Log Scale	0.776
95% t UCL (Assumes normality)	1.829	95% H-Stat UCL	2.45

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.743	KM H-UCL	0.822
95% KM (BCA) UCL	0.695		

Warning: Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	17	Mean	195.8
Maximum	1080	Median	64.8
SD	287	Std. Error of Mean	61.18
Coefficient of Variation	1.466	Skewness	2.03

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.655	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.331	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	301.1	95% Adjusted-CLT UCL (Chen-1995)	324.7
		95% Modified-t UCL (Johnson-1978)	305.5

Gamma GOF Test

A-D Test Statistic	1.533	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.785	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.258	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.193	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.732	k star (bias corrected MLE)	0.662
Theta hat (MLE)	267.5	Theta star (bias corrected MLE)	295.6
nu hat (MLE)	32.2	nu star (bias corrected)	29.15
MLE Mean (bias corrected)	195.8	MLE Sd (bias corrected)	240.6
		Approximate Chi Square Value (0.05)	17.82
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	17.16

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	320.2	95% Adjusted Gamma UCL (use when n<50)	332.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.175	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.833	Mean of logged Data	4.456
Maximum of Logged Data	6.985	SD of logged Data	1.247

Assuming Lognormal Distribution

95% H-UCL	417.5	90% Chebyshev (MVUE) UCL	342.4
95% Chebyshev (MVUE) UCL	417.3	97.5% Chebyshev (MVUE) UCL	521.3
99% Chebyshev (MVUE) UCL	725.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix D, Table 21. ProUCL Output - Shellfish (Sitewide)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	296.4	95% Jackknife UCL	301.1
95% Standard Bootstrap UCL	295.9	95% Bootstrap-t UCL	374.6
95% Hall's Bootstrap UCL	306.7	95% Percentile Bootstrap UCL	298.3
95% BCA Bootstrap UCL	337.8		
90% Chebyshev(Mean, Sd) UCL	379.3	95% Chebyshev(Mean, Sd) UCL	462.5
97.5% Chebyshev(Mean, Sd) UCL	577.9	99% Chebyshev(Mean, Sd) UCL	804.5

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	462.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 1:53:34 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	65.2	Mean	272.3
Maximum	794	Median	186.5
SD	224.8	Std. Error of Mean	64.89
Coefficient of Variation	0.826	Skewness	1.279

Normal GOF Test

Shapiro Wilk Test Statistic	0.852	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	388.8	95% Adjusted-CLT UCL (Chen-1995)	404.6
		95% Modified-t UCL (Johnson-1978)	392.8

Gamma GOF Test

A-D Test Statistic	0.403	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.172	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.249	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.76	k star (bias corrected MLE)	1.376
Theta hat (MLE)	154.7	Theta star (bias corrected MLE)	197.9
nu hat (MLE)	42.25	nu star (bias corrected)	33.02
MLE Mean (bias corrected)	272.3	MLE Sd (bias corrected)	232.1
		Approximate Chi Square Value (0.05)	20.88
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	19.42

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	430.6	95% Adjusted Gamma UCL (use when n<50)	463

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.17	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.177	Mean of logged Data	5.297
Maximum of Logged Data	6.677	SD of logged Data	0.832

Assuming Lognormal Distribution

95% H-UCL	545.5	90% Chebyshev (MVUE) UCL	479.4
95% Chebyshev (MVUE) UCL	573.1	97.5% Chebyshev (MVUE) UCL	703.3
99% Chebyshev (MVUE) UCL	959		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	379	95% Jackknife UCL	388.8
95% Standard Bootstrap UCL	374.1	95% Bootstrap-t UCL	432.6
95% Hall's Bootstrap UCL	458.3	95% Percentile Bootstrap UCL	381.2
95% BCA Bootstrap UCL	396.9		
90% Chebyshev(Mean, Sd) UCL	467	95% Chebyshev(Mean, Sd) UCL	555.2
97.5% Chebyshev(Mean, Sd) UCL	677.5	99% Chebyshev(Mean, Sd) UCL	918

Suggested UCL to Use

95% Student's-t UCL 388.8

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	10
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.37	Minimum Non-Detect	0.24
Maximum Detect	0.38	Maximum Non-Detect	0.24
Variance Detects	5.0000E-5	Percent Non-Detects	83.33%
Mean Detects	0.375	SD Detects	0.00707
Median Detects	0.375	CV Detects	0.0189
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.981	SD of Logged Detects	0.0189

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Warning: Data set has only 2 Detected Values.

This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.263	KM Standard Error of Mean	0.0206
KM SD	0.0504	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.299	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.296	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.324	95% KM Chebyshev UCL	0.352
97.5% KM Chebyshev UCL	0.391	99% KM Chebyshev UCL	0.467

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	5625	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6.6671E-5	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	22499	nu star (bias corrected)	N/A
Mean (detects)	0.375		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.263	SD (KM)	0.0504
Variance (KM)	0.00254	SE of Mean (KM)	0.0206
k hat (KM)	27.18	k star (KM)	20.44
nu hat (KM)	652.3	nu star (KM)	490.5
theta hat (KM)	0.00966	theta star (KM)	0.0128
80% gamma percentile (KM)	0.31	90% gamma percentile (KM)	0.339
95% gamma percentile (KM)	0.365	99% gamma percentile (KM)	0.416

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.029
Approximate Chi Square Value (490.53, α)	440.2	Adjusted Chi Square Value (490.53, β)	432.9
95% Gamma Approximate KM-UCL (use when n>=50)	0.293	95% Gamma Adjusted KM-UCL (use when n<50)	0.297

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.34	Mean in Log Scale	-1.081
SD in Original Scale	0.022	SD in Log Scale	0.0643
95% t UCL (assumes normality of ROS data)	0.351	95% Percentile Bootstrap UCL	0.35
95% BCA Bootstrap UCL	0.35	95% Bootstrap t UCL	0.352
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.353	KM Geo Mean	0.259
KM SD (logged)	0.166	95% Critical H Value (KM-Log)	1.818
KM Standard Error of Mean (logged)	0.0679	95% H-UCL (KM -Log)	0.287
KM SD (logged)	0.166	95% Critical H Value (KM-Log)	1.818
KM Standard Error of Mean (logged)	0.0679		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.163	Mean in Log Scale	-1.93
SD in Original Scale	0.0993	SD in Log Scale	0.444
95% t UCL (Assumes normality)	0.214	95% H-Stat UCL	0.211

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.299	KM H-UCL	0.287
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	13
Number of Detects	13	Number of Non-Detects	4
Number of Distinct Detects	12	Number of Distinct Non-Detects	1
Minimum Detect	0.35	Minimum Non-Detect	0.27
Maximum Detect	9.06	Maximum Non-Detect	0.27
Variance Detects	5.449	Percent Non-Detects	23.53%
Mean Detects	1.387	SD Detects	2.334
Median Detects	0.68	CV Detects	1.683
Skewness Detects	3.457	Kurtosis Detects	12.19
Mean of Logged Detects	-0.191	SD of Logged Detects	0.839

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.441	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.395	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.124	KM Standard Error of Mean	0.509
KM SD	2.018	95% KM (BCA) UCL	2.15
95% KM (t) UCL	2.013	95% KM (Percentile Bootstrap) UCL	2.115
95% KM (z) UCL	1.962	95% KM Bootstrap t UCL	5.92
90% KM Chebyshev UCL	2.652	95% KM Chebyshev UCL	3.344
97.5% KM Chebyshev UCL	4.305	99% KM Chebyshev UCL	6.192

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.806	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.756	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.309	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.243	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.102	k star (bias corrected MLE)	0.899
Theta hat (MLE)	1.259	Theta star (bias corrected MLE)	1.543
nu hat (MLE)	28.64	nu star (bias corrected)	23.37
Mean (detects)	1.387		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.063
Maximum	9.06	Median	0.58
SD	2.109	CV	1.984
k hat (MLE)	0.493	k star (bias corrected MLE)	0.445
Theta hat (MLE)	2.155	Theta star (bias corrected MLE)	2.387
nu hat (MLE)	16.77	nu star (bias corrected)	15.14
Adjusted Level of Significance (β)	0.0346		
Approximate Chi Square Value (15.14, α)	7.36	Adjusted Chi Square Value (15.14, β)	6.798
95% Gamma Approximate UCL (use when n>=50)	2.187	95% Gamma Adjusted UCL (use when n<50)	2.368

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.124	SD (KM)	2.018
Variance (KM)	4.071	SE of Mean (KM)	0.509
k hat (KM)	0.31	k star (KM)	0.295
nu hat (KM)	10.55	nu star (KM)	10.03
theta hat (KM)	3.621	theta star (KM)	3.812
80% gamma percentile (KM)	1.716	90% gamma percentile (KM)	3.322
95% gamma percentile (KM)	5.171	99% gamma percentile (KM)	9.985

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (10.03, α)	3.958	Adjusted Chi Square Value (10.03, β)	3.567
95% Gamma Approximate KM-UCL (use when n>=50)	2.848	95% Gamma Adjusted KM-UCL (use when n<50)	3.16

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.792	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.092	Mean in Log Scale	-0.631
SD in Original Scale	2.094	SD in Log Scale	1.108
95% t UCL (assumes normality of ROS data)	1.979	95% Percentile Bootstrap UCL	2.051
95% BCA Bootstrap UCL	2.633	95% Bootstrap t UCL	5.319
95% H-UCL (Log ROS)	2.153		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.454	KM Geo Mean	0.635
KM SD (logged)	0.85	95% Critical H Value (KM-Log)	2.431
KM Standard Error of Mean (logged)	0.215	95% H-UCL (KM -Log)	1.527
KM SD (logged)	0.85	95% Critical H Value (KM-Log)	2.431
KM Standard Error of Mean (logged)	0.215		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.092	Mean in Log Scale	-0.617
SD in Original Scale	2.094	SD in Log Scale	1.075
95% t UCL (Assumes normality)	1.979	95% H-Stat UCL	2.031

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 1.527

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	2.7	Mean	15.63
Maximum	32	Median	13.15
SD	10.01	Std. Error of Mean	2.89
Coefficient of Variation	0.641	Skewness	0.626

Normal GOF Test

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	20.82	95% Adjusted-CLT UCL (Chen-1995)	20.94
		95% Modified-t UCL (Johnson-1978)	20.91

Gamma GOF Test

A-D Test Statistic	0.269	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.136	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.248	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.438	k star (bias corrected MLE)	1.884
Theta hat (MLE)	6.409	Theta star (bias corrected MLE)	8.294
nu hat (MLE)	58.52	nu star (bias corrected)	45.23
MLE Mean (bias corrected)	15.63	MLE Sd (bias corrected)	11.38
		Approximate Chi Square Value (0.05)	30.8
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	28.99

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	22.95	95% Adjusted Gamma UCL (use when n<50)	24.38

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.13	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	2.53
Maximum of Logged Data	3.466	SD of logged Data	0.736

Assuming Lognormal Distribution

95% H-UCL	28.47	90% Chebyshev (MVUE) UCL	26.7
95% Chebyshev (MVUE) UCL	31.53	97.5% Chebyshev (MVUE) UCL	38.24
99% Chebyshev (MVUE) UCL	51.42		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	20.38	95% Jackknife UCL	20.82
95% Standard Bootstrap UCL	20.09	95% Bootstrap-t UCL	21.35
95% Hall's Bootstrap UCL	20.38	95% Percentile Bootstrap UCL	20.65
95% BCA Bootstrap UCL	20.59		
90% Chebyshev(Mean, Sd) UCL	24.3	95% Chebyshev(Mean, Sd) UCL	28.23
97.5% Chebyshev(Mean, Sd) UCL	33.68	99% Chebyshev(Mean, Sd) UCL	44.38

Suggested UCL to Use

95% Student's-t UCL	20.82

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	5
Number of Detects	6	Number of Non-Detects	6
Number of Distinct Detects	4	Number of Distinct Non-Detects	1
Minimum Detect	0.02	Minimum Non-Detect	0.01
Maximum Detect	0.07	Maximum Non-Detect	0.01
Variance Detects	4.6667E-4	Percent Non-Detects	50%
Mean Detects	0.0467	SD Detects	0.0216
Median Detects	0.055	CV Detects	0.463
Skewness Detects	-0.608	Kurtosis Detects	-1.843
Mean of Logged Detects	-3.184	SD of Logged Detects	0.574

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.839	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.231	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0283	KM Standard Error of Mean	0.00728
KM SD	0.023	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0414	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0403	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0502	95% KM Chebyshev UCL	0.0601
97.5% KM Chebyshev UCL	0.0738	99% KM Chebyshev UCL	0.101

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.712	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.699	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.287	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.333	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.341	k star (bias corrected MLE)	2.282
Theta hat (MLE)	0.0108	Theta star (bias corrected MLE)	0.0205
nu hat (MLE)	52.09	nu star (bias corrected)	27.38
Mean (detects)	0.0467		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0287
Maximum	0.07	Median	0.017
SD	0.0238	CV	0.831
k hat (MLE)	1.736	k star (bias corrected MLE)	1.358
Theta hat (MLE)	0.0165	Theta star (bias corrected MLE)	0.0211
nu hat (MLE)	41.67	nu star (bias corrected)	32.58
Adjusted Level of Significance (β)	0.029		
Approximate Chi Square Value (32.58, α)	20.53	Adjusted Chi Square Value (32.58, β)	19.09
95% Gamma Approximate UCL (use when n>=50)	0.0455	95% Gamma Adjusted UCL (use when n<50)	0.0489

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0283	SD (KM)	0.023
Variance (KM)	5.3056E-4	SE of Mean (KM)	0.00728
k hat (KM)	1.513	k star (KM)	1.19
nu hat (KM)	36.31	nu star (KM)	28.57
theta hat (KM)	0.0187	theta star (KM)	0.0238
80% gamma percentile (KM)	0.0449	90% gamma percentile (KM)	0.0625
95% gamma percentile (KM)	0.0799	99% gamma percentile (KM)	0.12

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (28.57, α)	17.37	Adjusted Chi Square Value (28.57, β)	16.05
95% Gamma Approximate KM-UCL (use when n>=50)	0.0466	95% Gamma Adjusted KM-UCL (use when n<50)	0.0504

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.776	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.788	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.295	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.325	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0282	Mean in Log Scale	-3.956
SD in Original Scale	0.0243	SD in Log Scale	0.954
95% t UCL (assumes normality of ROS data)	0.0408	95% Percentile Bootstrap UCL	0.0395
95% BCA Bootstrap UCL	0.0407	95% Bootstrap t UCL	0.0445
95% H-UCL (Log ROS)	0.0681		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.895	KM Geo Mean	0.0203
KM SD (logged)	0.801	95% Critical H Value (KM-Log)	2.572
KM Standard Error of Mean (logged)	0.253	95% H-UCL (KM -Log)	0.0522
KM SD (logged)	0.801	95% Critical H Value (KM-Log)	2.572
KM Standard Error of Mean (logged)	0.253		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0258	Mean in Log Scale	-4.241
SD in Original Scale	0.0262	SD in Log Scale	1.17
95% t UCL (Assumes normality)	0.0394	95% H-Stat UCL	0.0892

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0414

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	16
		Number of Missing Observations	0
Minimum	0.05	Mean	2.373
Maximum	21.2	Median	0.3
SD	5.224	Std. Error of Mean	1.267
Coefficient of Variation	2.201	Skewness	3.311

Normal GOF Test

Shapiro Wilk Test Statistic	0.495	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.342	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.585	95% Adjusted-CLT UCL (Chen-1995)	5.545
		95% Modified-t UCL (Johnson-1978)	4.755

Gamma GOF Test

A-D Test Statistic	1.554	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.812	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.308	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.223	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.435	k star (bias corrected MLE)	0.397
Theta hat (MLE)	5.459	Theta star (bias corrected MLE)	5.974
nu hat (MLE)	14.78	nu star (bias corrected)	13.51
MLE Mean (bias corrected)	2.373	MLE Sd (bias corrected)	3.765
		Approximate Chi Square Value (0.05)	6.235
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	5.724

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.141	95% Adjusted Gamma UCL (use when n<50)	5.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.913	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.24	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.207	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.996	Mean of logged Data	-0.629
Maximum of Logged Data	3.054	SD of logged Data	1.669

Assuming Lognormal Distribution

95% H-UCL	10.39	90% Chebyshev (MVUE) UCL	4.425
95% Chebyshev (MVUE) UCL	5.605	97.5% Chebyshev (MVUE) UCL	7.242
99% Chebyshev (MVUE) UCL	10.46		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.457	95% Jackknife UCL	4.585
95% Standard Bootstrap UCL	4.397	95% Bootstrap-t UCL	8.46
95% Hall's Bootstrap UCL	10.53	95% Percentile Bootstrap UCL	4.652
95% BCA Bootstrap UCL	6.235		
90% Chebyshev(Mean, Sd) UCL	6.175	95% Chebyshev(Mean, Sd) UCL	7.896
97.5% Chebyshev(Mean, Sd) UCL	10.29	99% Chebyshev(Mean, Sd) UCL	14.98

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL	14.98

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Number of Detects	11	Number of Non-Detects	1
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	0.08	Minimum Non-Detect	0.06
Maximum Detect	4.31	Maximum Non-Detect	0.06
Variance Detects	1.396	Percent Non-Detects	8.333%
Mean Detects	1.016	SD Detects	1.181
Median Detects	0.77	CV Detects	1.162
Skewness Detects	2.553	Kurtosis Detects	7.069
Mean of Logged Detects	-0.437	SD of Logged Detects	1.012

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.668	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.364	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.937	KM Standard Error of Mean	0.336
KM SD	1.11	95% KM (BCA) UCL	1.611
95% KM (t) UCL	1.54	95% KM (Percentile Bootstrap) UCL	1.51
95% KM (z) UCL	1.49	95% KM Bootstrap t UCL	2.651
90% KM Chebyshev UCL	1.945	95% KM Chebyshev UCL	2.402
97.5% KM Chebyshev UCL	3.036	99% KM Chebyshev UCL	4.282

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.524	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.259	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.261	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.245	k star (bias corrected MLE)	0.966
Theta hat (MLE)	0.817	Theta star (bias corrected MLE)	1.052
nu hat (MLE)	27.38	nu star (bias corrected)	21.25
Mean (detects)	1.016		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.933
Maximum	4.31	Median	0.625
SD	1.163	CV	1.248
k hat (MLE)	0.828	k star (bias corrected MLE)	0.676
Theta hat (MLE)	1.127	Theta star (bias corrected MLE)	1.379
nu hat (MLE)	19.86	nu star (bias corrected)	16.23
Adjusted Level of Significance (β)	0.029		
Approximate Chi Square Value (16.23, α)	8.124	Adjusted Chi Square Value (16.23, β)	7.264
95% Gamma Approximate UCL (use when n>=50)	1.863	95% Gamma Adjusted UCL (use when n<50)	2.083

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.937	SD (KM)	1.11
Variance (KM)	1.233	SE of Mean (KM)	0.336
k hat (KM)	0.712	k star (KM)	0.589
nu hat (KM)	17.08	nu star (KM)	14.14
theta hat (KM)	1.316	theta star (KM)	1.59
80% gamma percentile (KM)	1.544	90% gamma percentile (KM)	2.446
95% gamma percentile (KM)	3.393	99% gamma percentile (KM)	5.686

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (14.14, α)	6.668	Adjusted Chi Square Value (14.14, β)	5.902
95% Gamma Approximate KM-UCL (use when n>=50)	1.986	95% Gamma Adjusted KM-UCL (use when n<50)	2.244

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.937	Mean in Log Scale	-0.636
SD in Original Scale	1.16	SD in Log Scale	1.187
95% t UCL (assumes normality of ROS data)	1.538	95% Percentile Bootstrap UCL	1.536
95% BCA Bootstrap UCL	1.761	95% Bootstrap t UCL	2.617
95% H-UCL (Log ROS)	3.445		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.635	KM Geo Mean	0.53
KM SD (logged)	1.134	95% Critical H Value (KM-Log)	3.163
KM Standard Error of Mean (logged)	0.343	95% H-UCL (KM -Log)	2.974
KM SD (logged)	1.134	95% Critical H Value (KM-Log)	3.163
KM Standard Error of Mean (logged)	0.343		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.934	Mean in Log Scale	-0.692
SD in Original Scale	1.162	SD in Log Scale	1.31
95% t UCL (Assumes normality)	1.537	95% H-Stat UCL	4.724

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Bootstrap t UCL	2.651	KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	2.244

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.09	Mean	1.563
Maximum	7.91	Median	0.725
SD	2.302	Std. Error of Mean	0.664
Coefficient of Variation	1.472	Skewness	2.323

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.668	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.306	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.757	95% Adjusted-CLT UCL (Chen-1995)	3.132
		95% Modified-t UCL (Johnson-1978)	2.831

Gamma GOF Test

A-D Test Statistic	0.465	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.767	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.726	k star (bias corrected MLE)	0.6
Theta hat (MLE)	2.155	Theta star (bias corrected MLE)	2.607
nu hat (MLE)	17.41	nu star (bias corrected)	14.39
MLE Mean (bias corrected)	1.563	MLE Sd (bias corrected)	2.019
		Approximate Chi Square Value (0.05)	6.841
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	6.063

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	3.289	95% Adjusted Gamma UCL (use when n<50)	3.711

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.129	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.408	Mean of logged Data	-0.382
Maximum of Logged Data	2.068	SD of logged Data	1.353

Assuming Lognormal Distribution

95% H-UCL	7.39	90% Chebyshev (MVUE) UCL	3.434
95% Chebyshev (MVUE) UCL	4.306	97.5% Chebyshev (MVUE) UCL	5.518
99% Chebyshev (MVUE) UCL	7.898		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.656	95% Jackknife UCL	2.757
95% Standard Bootstrap UCL	2.584	95% Bootstrap-t UCL	5.453
95% Hall's Bootstrap UCL	7.772	95% Percentile Bootstrap UCL	2.739
95% BCA Bootstrap UCL	3.208		
90% Chebyshev(Mean, Sd) UCL	3.557	95% Chebyshev(Mean, Sd) UCL	4.46
97.5% Chebyshev(Mean, Sd) UCL	5.713	99% Chebyshev(Mean, Sd) UCL	8.175

Suggested UCL to Use

95% Adjusted Gamma UCL 3.711

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
Number of Detects	11	Number of Non-Detects	1
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	0.48	Minimum Non-Detect	0.06
Maximum Detect	22.7	Maximum Non-Detect	0.06
Variance Detects	42.62	Percent Non-Detects	8.333%
Mean Detects	4.285	SD Detects	6.528
Median Detects	1.92	CV Detects	1.524
Skewness Detects	2.695	Kurtosis Detects	7.553
Mean of Logged Detects	0.798	SD of Logged Detects	1.101

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.594	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.362	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	3.933	KM Standard Error of Mean	1.839
KM SD	6.073	95% KM (BCA) UCL	7.378
95% KM (t) UCL	7.234	95% KM (Percentile Bootstrap) UCL	7.194
95% KM (z) UCL	6.957	95% KM Bootstrap t UCL	19.26
90% KM Chebyshev UCL	9.448	95% KM Chebyshev UCL	11.95
97.5% KM Chebyshev UCL	15.41	99% KM Chebyshev UCL	22.23

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.82	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.756	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.242	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.263	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.891	k star (bias corrected MLE)	0.708
Theta hat (MLE)	4.81	Theta star (bias corrected MLE)	6.048
nu hat (MLE)	19.6	nu star (bias corrected)	15.59
Mean (detects)	4.285		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	3.928
Maximum	22.7	Median	1.705
SD	6.345	CV	1.615
k hat (MLE)	0.605	k star (bias corrected MLE)	0.509
Theta hat (MLE)	6.496	Theta star (bias corrected MLE)	7.716
nu hat (MLE)	14.51	nu star (bias corrected)	12.22
Adjusted Level of Significance (β)	0.029		
Approximate Chi Square Value (12.22, α)	5.371	Adjusted Chi Square Value (12.22, β)	4.697
95% Gamma Approximate UCL (use when n>=50)	8.936	95% Gamma Adjusted UCL (use when n<50)	10.22

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	3.933	SD (KM)	6.073
Variance (KM)	36.88	SE of Mean (KM)	1.839
k hat (KM)	0.419	k star (KM)	0.37
nu hat (KM)	10.06	nu star (KM)	8.882
theta hat (KM)	9.378	theta star (KM)	10.63
80% gamma percentile (KM)	6.282	90% gamma percentile (KM)	11.26
95% gamma percentile (KM)	16.78	99% gamma percentile (KM)	30.79

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (8.88, α)	3.256	Adjusted Chi Square Value (8.88, β)	2.757
95% Gamma Approximate KM-UCL (use when n>=50)	10.73	95% Gamma Adjusted KM-UCL (use when n<50)	12.67

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.158	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	3.94	Mean in Log Scale	0.576
SD in Original Scale	6.337	SD in Log Scale	1.301
95% t UCL (assumes normality of ROS data)	7.226	95% Percentile Bootstrap UCL	7.154
95% BCA Bootstrap UCL	8.418	95% Bootstrap t UCL	19.47
95% H-UCL (Log ROS)	16.31		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.497	KM Geo Mean	1.644
KM SD (logged)	1.417	95% Critical H Value (KM-Log)	3.723
KM Standard Error of Mean (logged)	0.429	95% H-UCL (KM -Log)	21.99
KM SD (logged)	1.417	95% Critical H Value (KM-Log)	3.723
KM Standard Error of Mean (logged)	0.429		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	3.93	Mean in Log Scale	0.439
SD in Original Scale	6.344	SD in Log Scale	1.627
95% t UCL (Assumes normality)	7.219	95% H-Stat UCL	44.83

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Bootstrap t UCL 19.26 95% KM-UCL (use when k<=1 and 15 < n < 50 but k<=1) 12.67

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	94.8	Mean	2442
Maximum	12100	Median	764
SD	3584	Std. Error of Mean	1035
Coefficient of Variation	1.468	Skewness	2.138

Normal GOF Test

Shapiro Wilk Test Statistic	0.693	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.305	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	4300	95% Adjusted-CLT UCL (Chen-1995)	4827
		95% Modified-t UCL (Johnson-1978)	4407

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	0.479	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.773	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.215	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.658	k star (bias corrected MLE)	0.549
Theta hat (MLE)	3712	Theta star (bias corrected MLE)	4449
nu hat (MLE)	15.79	nu star (bias corrected)	13.17
MLE Mean (bias corrected)	2442	MLE Sd (bias corrected)	3296
		Approximate Chi Square Value (0.05)	6.011
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	5.29

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	5353	95% Adjusted Gamma UCL (use when n<50)	6083

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.139	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.552	Mean of logged Data	6.874
Maximum of Logged Data	9.401	SD of logged Data	1.462

Assuming Lognormal Distribution

95% H-UCL	15117	90% Chebyshev (MVUE) UCL	5763
95% Chebyshev (MVUE) UCL	7279	97.5% Chebyshev (MVUE) UCL	9383
99% Chebyshev (MVUE) UCL	13517		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4144	95% Jackknife UCL	4300
95% Standard Bootstrap UCL	4063	95% Bootstrap-t UCL	6843
95% Hall's Bootstrap UCL	10135	95% Percentile Bootstrap UCL	4255
95% BCA Bootstrap UCL	4888		
90% Chebyshev(Mean, Sd) UCL	5546	95% Chebyshev(Mean, Sd) UCL	6953
97.5% Chebyshev(Mean, Sd) UCL	8904	99% Chebyshev(Mean, Sd) UCL	12738

Suggested UCL to Use

95% Adjusted Gamma UCL 6083

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lead (mg/kg)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	0.37	Mean	70.86
Maximum	838	Median	2.43
SD	210.6	Std. Error of Mean	51.09
Coefficient of Variation	2.972	Skewness	3.483

Normal GOF Test

Shapiro Wilk Test Statistic	0.387	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.482	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	160.1	95% Adjusted-CLT UCL (Chen-1995)	201
		95% Modified-t UCL (Johnson-1978)	167.3

Gamma GOF Test

A-D Test Statistic	2.701	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.863	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.341	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.253	k star (bias corrected MLE)	0.247
Theta hat (MLE)	280.5	Theta star (bias corrected MLE)	286.6
nu hat (MLE)	8.59	nu star (bias corrected)	8.407
MLE Mean (bias corrected)	70.86	MLE Sd (bias corrected)	142.5
		Approximate Chi Square Value (0.05)	2.973
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	2.644

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	200.4	95% Adjusted Gamma UCL (use when n<50)	225.3

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.207	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.994	Mean of logged Data	1.454
Maximum of Logged Data	6.731	SD of logged Data	2.101

Assuming Lognormal Distribution

95% H-UCL	430.8	90% Chebyshev (MVUE) UCL	79.5
95% Chebyshev (MVUE) UCL	102.7	97.5% Chebyshev (MVUE) UCL	134.9
99% Chebyshev (MVUE) UCL	198.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	154.9	95% Jackknife UCL	160.1
95% Standard Bootstrap UCL	151.6	95% Bootstrap-t UCL	3113
95% Hall's Bootstrap UCL	2038	95% Percentile Bootstrap UCL	156.4
95% BCA Bootstrap UCL	217.9		
90% Chebyshev(Mean, Sd) UCL	224.1	95% Chebyshev(Mean, Sd) UCL	293.6
97.5% Chebyshev(Mean, Sd) UCL	389.9	99% Chebyshev(Mean, Sd) UCL	579.2

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL 579.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	14.4	Mean	204.9
Maximum	566	Median	148.5
SD	186.1	Std. Error of Mean	53.73
Coefficient of Variation	0.908	Skewness	1.09

Normal GOF Test

Shapiro Wilk Test Statistic	0.859	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.22	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	301.4	95% Adjusted-CLT UCL (Chen-1995)	311.3
		95% Modified-t UCL (Johnson-1978)	304.2

Gamma GOF Test

A-D Test Statistic	0.262	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.136	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.252	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	1.141	k star (bias corrected MLE)	0.911
Theta hat (MLE)	179.6	Theta star (bias corrected MLE)	224.9
nu hat (MLE)	27.38	nu star (bias corrected)	21.87
MLE Mean (bias corrected)	204.9	MLE Sd (bias corrected)	214.7
		Approximate Chi Square Value (0.05)	12.24
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	11.15

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	366.1	95% Adjusted Gamma UCL (use when n<50)	401.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.193	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.667	Mean of logged Data	4.824
Maximum of Logged Data	6.339	SD of logged Data	1.182

Assuming Lognormal Distribution

95% H-UCL	798.5	90% Chebyshev (MVUE) UCL	483.9
95% Chebyshev (MVUE) UCL	599.1	97.5% Chebyshev (MVUE) UCL	759
99% Chebyshev (MVUE) UCL	1073		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	293.3	95% Jackknife UCL	301.4
95% Standard Bootstrap UCL	287.1	95% Bootstrap-t UCL	372.8
95% Hall's Bootstrap UCL	357.5	95% Percentile Bootstrap UCL	295.9
95% BCA Bootstrap UCL	308		
90% Chebyshev(Mean, Sd) UCL	366.1	95% Chebyshev(Mean, Sd) UCL	439.1
97.5% Chebyshev(Mean, Sd) UCL	540.4	99% Chebyshev(Mean, Sd) UCL	739.5

Suggested UCL to Use

95% Student's-t UCL	301.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Mercury (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	8.4700E-4	Mean	0.0119
Maximum	0.0936	Median	0.00203
SD	0.0264	Std. Error of Mean	0.00761
Coefficient of Variation	2.213	Skewness	3.194

Normal GOF Test

Shapiro Wilk Test Statistic	0.468	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.377	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0256	95% Adjusted-CLT UCL (Chen-1995)	0.0319
		95% Modified-t UCL (Johnson-1978)	0.0268

Gamma GOF Test

A-D Test Statistic	1.655	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.783	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.356	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.258	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.528	k star (bias corrected MLE)	0.452
Theta hat (MLE)	0.0226	Theta star (bias corrected MLE)	0.0264
nu hat (MLE)	12.67	nu star (bias corrected)	10.84
MLE Mean (bias corrected)	0.0119	MLE Sd (bias corrected)	0.0177
		Approximate Chi Square Value (0.05)	4.472
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	3.867

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0289	95% Adjusted Gamma UCL (use when n<50)	0.0334

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.269	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-7.074	Mean of logged Data	-5.623
Maximum of Logged Data	-2.369	SD of logged Data	1.361

Assuming Lognormal Distribution

95% H-UCL	0.0401	90% Chebyshev (MVUE) UCL	0.0184
95% Chebyshev (MVUE) UCL	0.0231	97.5% Chebyshev (MVUE) UCL	0.0296
99% Chebyshev (MVUE) UCL	0.0424		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0244	95% Jackknife UCL	0.0256
95% Standard Bootstrap UCL	0.0242	95% Bootstrap-t UCL	0.105
95% Hall's Bootstrap UCL	0.101	95% Percentile Bootstrap UCL	0.0257
95% BCA Bootstrap UCL	0.0358		
90% Chebyshev(Mean, Sd) UCL	0.0348	95% Chebyshev(Mean, Sd) UCL	0.0451
97.5% Chebyshev(Mean, Sd) UCL	0.0595	99% Chebyshev(Mean, Sd) UCL	0.0877

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL 0.0451

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.28	Mean	1.198
Maximum	3.58	Median	0.955
SD	0.974	Std. Error of Mean	0.281
Coefficient of Variation	0.813	Skewness	1.478

Normal GOF Test

Shapiro Wilk Test Statistic	0.849	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.181	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.702	95% Adjusted-CLT UCL (Chen-1995)	1.788
		95% Modified-t UCL (Johnson-1978)	1.722

Gamma GOF Test

A-D Test Statistic	0.302	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.177	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.249	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	1.88	k star (bias corrected MLE)	1.465
Theta hat (MLE)	0.637	Theta star (bias corrected MLE)	0.817
nu hat (MLE)	45.11	nu star (bias corrected)	35.17
MLE Mean (bias corrected)	1.198	MLE Sd (bias corrected)	0.989
		Approximate Chi Square Value (0.05)	22.6
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	21.07

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.863	95% Adjusted Gamma UCL (use when n<50)	1.998

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.958	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.153	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.273	Mean of logged Data	-0.109
Maximum of Logged Data	1.275	SD of logged Data	0.803

Assuming Lognormal Distribution

95% H-UCL	2.312	90% Chebyshev (MVUE) UCL	2.075
95% Chebyshev (MVUE) UCL	2.472	97.5% Chebyshev (MVUE) UCL	3.023
99% Chebyshev (MVUE) UCL	4.106		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.66	95% Jackknife UCL	1.702
95% Standard Bootstrap UCL	1.639	95% Bootstrap-t UCL	1.969
95% Hall's Bootstrap UCL	2.644	95% Percentile Bootstrap UCL	1.67
95% BCA Bootstrap UCL	1.775		
90% Chebyshev(Mean, Sd) UCL	2.041	95% Chebyshev(Mean, Sd) UCL	2.423
97.5% Chebyshev(Mean, Sd) UCL	2.953	99% Chebyshev(Mean, Sd) UCL	3.995

Suggested UCL to Use

95% Student's-t UCL 1.702

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Silver (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	11
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Silver (mg/kg) was not processed!

Vanadium (mg/kg)

General Statistics

Total Number of Observations	12	Number of Distinct Observations	12
		Number of Missing Observations	0
Minimum	0.31	Mean	1.396
Maximum	5.05	Median	1.15
SD	1.361	Std. Error of Mean	0.393
Coefficient of Variation	0.975	Skewness	2.013

Normal GOF Test

Shapiro Wilk Test Statistic	0.769	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.259	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.101	95% Adjusted-CLT UCL (Chen-1995)	2.286
		95% Modified-t UCL (Johnson-1978)	2.139

Gamma GOF Test

A-D Test Statistic	0.398	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.18	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.25	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.508	k star (bias corrected MLE)	1.187
Theta hat (MLE)	0.925	Theta star (bias corrected MLE)	1.176
nu hat (MLE)	36.2	nu star (bias corrected)	28.48
MLE Mean (bias corrected)	1.396	MLE Sd (bias corrected)	1.281
		Approximate Chi Square Value (0.05)	17.3
Adjusted Level of Significance	0.029	Adjusted Chi Square Value	15.99

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.298	95% Adjusted Gamma UCL (use when n<50)	2.487

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.859	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.161	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.243	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.171	Mean of logged Data	-0.0333
Maximum of Logged Data	1.619	SD of logged Data	0.887

Assuming Lognormal Distribution

95% H-UCL	2.966	90% Chebyshev (MVUE) UCL	2.494
95% Chebyshev (MVUE) UCL	3.001	97.5% Chebyshev (MVUE) UCL	3.705
99% Chebyshev (MVUE) UCL	5.087		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.042	95% Jackknife UCL	2.101
95% Standard Bootstrap UCL	2.006	95% Bootstrap-t UCL	2.774
95% Hall's Bootstrap UCL	5.249	95% Percentile Bootstrap UCL	2.083
95% BCA Bootstrap UCL	2.329		
90% Chebyshev(Mean, Sd) UCL	2.574	95% Chebyshev(Mean, Sd) UCL	3.108
97.5% Chebyshev(Mean, Sd) UCL	3.849	99% Chebyshev(Mean, Sd) UCL	5.304

Suggested UCL to Use

95% Adjusted Gamma UCL	2.487

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	17	Number of Distinct Observations	17
		Number of Missing Observations	0
Minimum	8.87	Mean	278
Maximum	1840	Median	46.9
SD	481.8	Std. Error of Mean	116.9
Coefficient of Variation	1.733	Skewness	2.497

Normal GOF Test

Shapiro Wilk Test Statistic	0.615	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.328	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	482	95% Adjusted-CLT UCL (Chen-1995)	545.9
		95% Modified-t UCL (Johnson-1978)	493.8

Gamma GOF Test

A-D Test Statistic	1.42	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.797	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.322	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.221	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.514	k star (bias corrected MLE)	0.463
Theta hat (MLE)	540.6	Theta star (bias corrected MLE)	600.8
nu hat (MLE)	17.49	nu star (bias corrected)	15.73
MLE Mean (bias corrected)	278	MLE Sd (bias corrected)	408.7
		Approximate Chi Square Value (0.05)	7.774
Adjusted Level of Significance	0.0346	Adjusted Chi Square Value	7.194

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	562.7	95% Adjusted Gamma UCL (use when n<50)	608.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.895	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.892	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.263	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.207	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.183	Mean of logged Data	4.398
Maximum of Logged Data	7.518	SD of logged Data	1.58

Assuming Lognormal Distribution

95% H-UCL	1186	90% Chebyshev (MVUE) UCL	578.1
95% Chebyshev (MVUE) UCL	728.4	97.5% Chebyshev (MVUE) UCL	937.1
99% Chebyshev (MVUE) UCL	1347		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	470.2	95% Jackknife UCL	482
95% Standard Bootstrap UCL	462.2	95% Bootstrap-t UCL	695.1
95% Hall's Bootstrap UCL	703.3	95% Percentile Bootstrap UCL	489.5
95% BCA Bootstrap UCL	575.2		
90% Chebyshev(Mean, Sd) UCL	628.6	95% Chebyshev(Mean, Sd) UCL	787.4
97.5% Chebyshev(Mean, Sd) UCL	1008	99% Chebyshev(Mean, Sd) UCL	1441

Appendix D, Table 22. ProUCL Output - Aquatic Plants as Food
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL 1441

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 2:05:53 PM
From File	TCOU5 ProUCL Tables 190506_f.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	65.2	Mean	292.5
Maximum	794	Median	202
SD	248.5	Std. Error of Mean	82.84
Coefficient of Variation	0.85	Skewness	1.149

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.869	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	446.6	95% Adjusted-CLT UCL (Chen-1995)	462.7
		95% Modified-t UCL (Johnson-1978)	451.9

Gamma GOF Test

A-D Test Statistic	0.308	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.733	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.284	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.624	k star (bias corrected MLE)	1.157
Theta hat (MLE)	180.1	Theta star (bias corrected MLE)	252.9
nu hat (MLE)	29.23	nu star (bias corrected)	20.82
MLE Mean (bias corrected)	292.5	MLE Sd (bias corrected)	272
		Approximate Chi Square Value (0.05)	11.46
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	10.02

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	531.6	95% Adjusted Gamma UCL (use when n<50)	607.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.177	Mean of logged Data	5.34
Maximum of Logged Data	6.677	SD of logged Data	0.894

Assuming Lognormal Distribution

95% H-UCL	803.8	90% Chebyshev (MVUE) UCL	565.1
95% Chebyshev (MVUE) UCL	687.9	97.5% Chebyshev (MVUE) UCL	858.4
99% Chebyshev (MVUE) UCL	1193		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	428.8	95% Jackknife UCL	446.6
95% Standard Bootstrap UCL	422.1	95% Bootstrap-t UCL	531.5
95% Hall's Bootstrap UCL	532.1	95% Percentile Bootstrap UCL	431
95% BCA Bootstrap UCL	443.8		
90% Chebyshev(Mean, Sd) UCL	541.1	95% Chebyshev(Mean, Sd) UCL	653.6
97.5% Chebyshev(Mean, Sd) UCL	809.9	99% Chebyshev(Mean, Sd) UCL	1117

Suggested UCL to Use

95% Student's-t UCL 446.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	7
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.37	Minimum Non-Detect	0.24
Maximum Detect	0.38	Maximum Non-Detect	0.24
Variance Detects	5.0000E-5	Percent Non-Detects	77.78%
Mean Detects	0.375	SD Detects	0.00707
Median Detects	0.375	CV Detects	0.0189
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.981	SD of Logged Detects	0.0189

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.27	KM Standard Error of Mean	0.0265
KM SD	0.0562	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.319	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.314	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.349	95% KM Chebyshev UCL	0.385
97.5% KM Chebyshev UCL	0.435	99% KM Chebyshev UCL	0.533

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	5625	k star (bias corrected MLE)	N/A
Theta hat (MLE)	6.6671E-5	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	22499	nu star (bias corrected)	N/A
Mean (detects)	0.375		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.27	SD (KM)	0.0562
Variance (KM)	0.00316	SE of Mean (KM)	0.0265
k hat (KM)	23.1	k star (KM)	15.48
nu hat (KM)	415.8	nu star (KM)	278.6
theta hat (KM)	0.0117	theta star (KM)	0.0174
80% gamma percentile (KM)	0.325	90% gamma percentile (KM)	0.361
95% gamma percentile (KM)	0.392	99% gamma percentile (KM)	0.455

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0231
Approximate Chi Square Value (278.56, α)	240.9	Adjusted Chi Square Value (278.56, β)	233.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.312	95% Gamma Adjusted KM-UCL (use when n<50)	0.322

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.346	Mean in Log Scale	-1.063
SD in Original Scale	0.0204	SD in Log Scale	0.0587
95% t UCL (assumes normality of ROS data)	0.359	95% Percentile Bootstrap UCL	0.357
95% BCA Bootstrap UCL	0.358	95% Bootstrap t UCL	0.361
95% H-UCL (Log ROS)	N/A		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.328	KM Geo Mean	0.265
KM SD (logged)	0.186	95% Critical H Value (KM-Log)	1.895
KM Standard Error of Mean (logged)	0.0875	95% H-UCL (KM -Log)	0.305
KM SD (logged)	0.186	95% Critical H Value (KM-Log)	1.895
KM Standard Error of Mean (logged)	0.0875		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.177	Mean in Log Scale	-1.867
SD in Original Scale	0.112	SD in Log Scale	0.502
95% t UCL (Assumes normality)	0.246	95% H-Stat UCL	0.261

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.319	KM H-UCL	0.305
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	3
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.35	Minimum Non-Detect	0.27
Maximum Detect	9.06	Maximum Non-Detect	0.27
Variance Detects	8.72	Percent Non-Detects	27.27%
Mean Detects	1.835	SD Detects	2.953
Median Detects	0.76	CV Detects	1.609
Skewness Detects	2.706	Kurtosis Detects	7.454
Mean of Logged Detects	-0.0386	SD of Logged Detects	1.044

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.55	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.391	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.408	KM Standard Error of Mean	0.792
KM SD	2.457	95% KM (BCA) UCL	2.906
95% KM (t) UCL	2.843	95% KM (Percentile Bootstrap) UCL	2.908
95% KM (z) UCL	2.711	95% KM Bootstrap t UCL	10.08
90% KM Chebyshev UCL	3.784	95% KM Chebyshev UCL	4.86
97.5% KM Chebyshev UCL	6.353	99% KM Chebyshev UCL	9.287

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.945	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.739	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.283	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.302	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.905	k star (bias corrected MLE)	0.649
Theta hat (MLE)	2.028	Theta star (bias corrected MLE)	2.828
nu hat (MLE)	14.48	nu star (bias corrected)	10.38
Mean (detects)	1.835		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.337
Maximum	9.06	Median	0.51
SD	2.614	CV	1.954
k hat (MLE)	0.415	k star (bias corrected MLE)	0.363
Theta hat (MLE)	3.22	Theta star (bias corrected MLE)	3.687
nu hat (MLE)	9.138	nu star (bias corrected)	7.979
Adjusted Level of Significance (β)	0.0278		
Approximate Chi Square Value (7.98, α)	2.723	Adjusted Chi Square Value (7.98, β)	2.248
95% Gamma Approximate UCL (use when n>=50)	3.919	95% Gamma Adjusted UCL (use when n<50)	4.746

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.408	SD (KM)	2.457
Variance (KM)	6.035	SE of Mean (KM)	0.792
k hat (KM)	0.329	k star (KM)	0.3
nu hat (KM)	7.229	nu star (KM)	6.591
theta hat (KM)	4.286	theta star (KM)	4.701
80% gamma percentile (KM)	2.159	90% gamma percentile (KM)	4.154
95% gamma percentile (KM)	6.445	99% gamma percentile (KM)	12.4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (6.59, α)	1.949	Adjusted Chi Square Value (6.59, β)	1.565
95% Gamma Approximate KM-UCL (use when n>=50)	4.762	95% Gamma Adjusted KM-UCL (use when n<50)	5.929

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.859	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.199	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.357	Mean in Log Scale	-0.736
SD in Original Scale	2.603	SD in Log Scale	1.5
95% t UCL (assumes normality of ROS data)	2.779	95% Percentile Bootstrap UCL	2.894
95% BCA Bootstrap UCL	3.63	95% Bootstrap t UCL	8.483
95% H-UCL (Log ROS)	10.01		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.385	KM Geo Mean	0.68
KM SD (logged)	1.007	95% Critical H Value (KM-Log)	3.012
KM Standard Error of Mean (logged)	0.325	95% H-UCL (KM -Log)	2.948
KM SD (logged)	1.007	95% Critical H Value (KM-Log)	3.012
KM Standard Error of Mean (logged)	0.325		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.371	Mean in Log Scale	-0.574
SD in Original Scale	2.595	SD in Log Scale	1.267
95% t UCL (Assumes normality)	2.79	95% H-Stat UCL	5.178

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Bootstrap t UCL	10.08	95% KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	5.929

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	2.7	Mean	14.2
Maximum	31	Median	11.5
SD	9.618	Std. Error of Mean	3.206
Coefficient of Variation	0.678	Skewness	0.895

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.899	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.187	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	20.16	95% Adjusted-CLT UCL (Chen-1995)	20.49
		95% Modified-t UCL (Johnson-1978)	20.32

Gamma GOF Test

A-D Test Statistic	0.215	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.138	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.282	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.357	k star (bias corrected MLE)	1.646
Theta hat (MLE)	6.022	Theta star (bias corrected MLE)	8.627
nu hat (MLE)	42.43	nu star (bias corrected)	29.62
MLE Mean (bias corrected)	14.2	MLE Sd (bias corrected)	11.07
		Approximate Chi Square Value (0.05)	18.19
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	16.33

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	23.11	95% Adjusted Gamma UCL (use when n<50)	25.74

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.152	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	2.426
Maximum of Logged Data	3.434	SD of logged Data	0.756

Assuming Lognormal Distribution

95% H-UCL	31.19	90% Chebyshev (MVUE) UCL	25.75
95% Chebyshev (MVUE) UCL	30.85	97.5% Chebyshev (MVUE) UCL	37.92
99% Chebyshev (MVUE) UCL	51.82		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	19.47	95% Jackknife UCL	20.16
95% Standard Bootstrap UCL	19.13	95% Bootstrap-t UCL	24.02
95% Hall's Bootstrap UCL	28	95% Percentile Bootstrap UCL	19.44
95% BCA Bootstrap UCL	20.34		
90% Chebyshev(Mean, Sd) UCL	23.81	95% Chebyshev(Mean, Sd) UCL	28.17
97.5% Chebyshev(Mean, Sd) UCL	34.22	99% Chebyshev(Mean, Sd) UCL	46.1

Suggested UCL to Use

95% Student's-t UCL 20.16

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	3
Number of Detects	4	Number of Non-Detects	5
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.02	Minimum Non-Detect	0.01
Maximum Detect	0.06	Maximum Non-Detect	0.01
Variance Detects	5.3333E-4	Percent Non-Detects	55.56%
Mean Detects	0.04	SD Detects	0.0231
Median Detects	0.04	CV Detects	0.577
Skewness Detects	1.284E-15	Kurtosis Detects	-6
Mean of Logged Detects	-3.363	SD of Logged Detects	0.634

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.731	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.307	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0233	KM Standard Error of Mean	0.0077
KM SD	0.02	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0376	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.036	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0464	95% KM Chebyshev UCL	0.0569
97.5% KM Chebyshev UCL	0.0714	99% KM Chebyshev UCL	0.0999

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.718	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.659	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.341	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.634	k star (bias corrected MLE)	1.075
Theta hat (MLE)	0.011	Theta star (bias corrected MLE)	0.0372
nu hat (MLE)	29.07	nu star (bias corrected)	8.602
Mean (detects)	0.04		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0233
Maximum	0.06	Median	0.01
SD	0.0212	CV	0.909
k hat (MLE)	1.844	k star (bias corrected MLE)	1.303
Theta hat (MLE)	0.0127	Theta star (bias corrected MLE)	0.0179
nu hat (MLE)	33.18	nu star (bias corrected)	23.46
Adjusted Level of Significance (β)	0.0231		
Approximate Chi Square Value (23.46, α)	13.44	Adjusted Chi Square Value (23.46, β)	11.87
95% Gamma Approximate UCL (use when n>=50)	0.0407	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0233	SD (KM)	0.02
Variance (KM)	4.0000E-4	SE of Mean (KM)	0.0077
k hat (KM)	1.361	k star (KM)	0.981
nu hat (KM)	24.5	nu star (KM)	17.67
theta hat (KM)	0.0171	theta star (KM)	0.0238
80% gamma percentile (KM)	0.0376	90% gamma percentile (KM)	0.054
95% gamma percentile (KM)	0.0704	99% gamma percentile (KM)	0.108

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (17.67, α)	9.15	Adjusted Chi Square Value (17.67, β)	7.892
95% Gamma Approximate KM-UCL (use when n>=50)	0.045	95% Gamma Adjusted KM-UCL (use when n<50)	0.0522

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.731	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.307	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.021	Mean in Log Scale	-4.439
SD in Original Scale	0.023	SD in Log Scale	1.182
95% t UCL (assumes normality of ROS data)	0.0353	95% Percentile Bootstrap UCL	0.0335
95% BCA Bootstrap UCL	0.0367	95% Bootstrap t UCL	0.0612
95% H-UCL (Log ROS)	0.11		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.053	KM Geo Mean	0.0174
KM SD (logged)	0.718	95% Critical H Value (KM-Log)	2.652
KM Standard Error of Mean (logged)	0.276	95% H-UCL (KM -Log)	0.0441
KM SD (logged)	0.718	95% Critical H Value (KM-Log)	2.652
KM Standard Error of Mean (logged)	0.276		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0206	Mean in Log Scale	-4.438
SD in Original Scale	0.0232	SD in Log Scale	1.092
95% t UCL (Assumes normality)	0.035	95% H-Stat UCL	0.0811

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0376

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	10
		Number of Missing Observations	0
Minimum	0.05	Mean	2.918
Maximum	21.2	Median	0.26
SD	6.364	Std. Error of Mean	1.919
Coefficient of Variation	2.181	Skewness	2.85

Normal GOF Test

Shapiro Wilk Test Statistic	0.52	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.367	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	6.396	95% Adjusted-CLT UCL (Chen-1995)	7.836
		95% Modified-t UCL (Johnson-1978)	6.671

Gamma GOF Test

A-D Test Statistic	1.169	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.802	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.297	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.273	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.392	k star (bias corrected MLE)	0.346
Theta hat (MLE)	7.446	Theta star (bias corrected MLE)	8.443
nu hat (MLE)	8.622	nu star (bias corrected)	7.604
MLE Mean (bias corrected)	2.918	MLE Sd (bias corrected)	4.964
		Approximate Chi Square Value (0.05)	2.508
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	2.057

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8.848	95% Adjusted Gamma UCL (use when n<50)	10.79

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.225	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.996	Mean of logged Data	-0.614
Maximum of Logged Data	3.054	SD of logged Data	1.813

Assuming Lognormal Distribution

95% H-UCL	42.22	90% Chebyshev (MVUE) UCL	5.736
95% Chebyshev (MVUE) UCL	7.39	97.5% Chebyshev (MVUE) UCL	9.686
99% Chebyshev (MVUE) UCL	14.2		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6.074	95% Jackknife UCL	6.396
95% Standard Bootstrap UCL	6.012	95% Bootstrap-t UCL	29.93
95% Hall's Bootstrap UCL	29.02	95% Percentile Bootstrap UCL	6.368
95% BCA Bootstrap UCL	8.646		
90% Chebyshev(Mean, Sd) UCL	8.675	95% Chebyshev(Mean, Sd) UCL	11.28
97.5% Chebyshev(Mean, Sd) UCL	14.9	99% Chebyshev(Mean, Sd) UCL	22.01

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL	22.01

Recommended UCL exceeds the maximum observation

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	1
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.08	Minimum Non-Detect	0.06
Maximum Detect	4.31	Maximum Non-Detect	0.06
Variance Detects	1.919	Percent Non-Detects	11.11%
Mean Detects	1.136	SD Detects	1.385
Median Detects	0.66	CV Detects	1.219
Skewness Detects	2.136	Kurtosis Detects	4.769
Mean of Logged Detects	-0.449	SD of Logged Detects	1.194

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.729	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.329	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.017	KM Standard Error of Mean	0.452
KM SD	1.268	95% KM (BCA) UCL	1.838
95% KM (t) UCL	1.857	95% KM (Percentile Bootstrap) UCL	1.738
95% KM (z) UCL	1.76	95% KM Bootstrap t UCL	3.692
90% KM Chebyshev UCL	2.372	95% KM Chebyshev UCL	2.986
97.5% KM Chebyshev UCL	3.838	99% KM Chebyshev UCL	5.511

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.308	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.735	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.219	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.301	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.001	k star (bias corrected MLE)	0.709
Theta hat (MLE)	1.135	Theta star (bias corrected MLE)	1.603
nu hat (MLE)	16.01	nu star (bias corrected)	11.34
Mean (detects)	1.136		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.011
Maximum	4.31	Median	0.48
SD	1.349	CV	1.334
k hat (MLE)	0.661	k star (bias corrected MLE)	0.515
Theta hat (MLE)	1.53	Theta star (bias corrected MLE)	1.965
nu hat (MLE)	11.9	nu star (bias corrected)	9.264
Adjusted Level of Significance (β)	0.0231		
Approximate Chi Square Value (9.26, α)	3.487	Adjusted Chi Square Value (9.26, β)	2.782
95% Gamma Approximate UCL (use when n>=50)	2.686	95% Gamma Adjusted UCL (use when n<50)	3.367

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.017	SD (KM)	1.268
Variance (KM)	1.607	SE of Mean (KM)	0.452
k hat (KM)	0.643	k star (KM)	0.503
nu hat (KM)	11.58	nu star (KM)	9.052
theta hat (KM)	1.581	theta star (KM)	2.022
80% gamma percentile (KM)	1.67	90% gamma percentile (KM)	2.747
95% gamma percentile (KM)	3.897	99% gamma percentile (KM)	6.724

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (9.05, α)	3.359	Adjusted Chi Square Value (9.05, β)	2.67
95% Gamma Approximate KM-UCL (use when n>=50)	2.74	95% Gamma Adjusted KM-UCL (use when n<50)	3.448

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.978	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.014	Mean in Log Scale	-0.774
SD in Original Scale	1.347	SD in Log Scale	1.483
95% t UCL (assumes normality of ROS data)	1.849	95% Percentile Bootstrap UCL	1.761
95% BCA Bootstrap UCL	2.12	95% Bootstrap t UCL	3.663
95% H-UCL (Log ROS)	13.91		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.712	KM Geo Mean	0.491
KM SD (logged)	1.289	95% Critical H Value (KM-Log)	3.914
KM Standard Error of Mean (logged)	0.459	95% H-UCL (KM -Log)	6.697
KM SD (logged)	1.289	95% Critical H Value (KM-Log)	3.914
KM Standard Error of Mean (logged)	0.459		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.013	Mean in Log Scale	-0.789
SD in Original Scale	1.347	SD in Log Scale	1.512
95% t UCL (Assumes normality)	1.848	95% H-Stat UCL	15.56

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Bootstrap t UCL	3.692	KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	3.448

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.09	Mean	1.778
Maximum	7.91	Median	0.64
SD	2.642	Std. Error of Mean	0.881
Coefficient of Variation	1.486	Skewness	1.968

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.702	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.31	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.416	95% Adjusted-CLT UCL (Chen-1995)	3.844
		95% Modified-t UCL (Johnson-1978)	3.512

Gamma GOF Test

A-D Test Statistic	0.45	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.762	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.207	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.292	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.619	k star (bias corrected MLE)	0.487
Theta hat (MLE)	2.871	Theta star (bias corrected MLE)	3.652
nu hat (MLE)	11.14	nu star (bias corrected)	8.763
MLE Mean (bias corrected)	1.778	MLE Sd (bias corrected)	2.548
		Approximate Chi Square Value (0.05)	3.184
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	2.518

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	4.892	95% Adjusted Gamma UCL (use when n<50)	6.187

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.172	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.408	Mean of logged Data	-0.418
Maximum of Logged Data	2.068	SD of logged Data	1.533

Assuming Lognormal Distribution

95% H-UCL	24.81	90% Chebyshev (MVUE) UCL	4.419
95% Chebyshev (MVUE) UCL	5.645	97.5% Chebyshev (MVUE) UCL	7.347
99% Chebyshev (MVUE) UCL	10.69		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.227	95% Jackknife UCL	3.416
95% Standard Bootstrap UCL	3.117	95% Bootstrap-t UCL	8.108
95% Hall's Bootstrap UCL	9.709	95% Percentile Bootstrap UCL	3.243
95% BCA Bootstrap UCL	3.766		
90% Chebyshev(Mean, Sd) UCL	4.42	95% Chebyshev(Mean, Sd) UCL	5.617
97.5% Chebyshev(Mean, Sd) UCL	7.278	99% Chebyshev(Mean, Sd) UCL	10.54

Suggested UCL to Use

95% Adjusted Gamma UCL	6.187

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	1
Number of Distinct Detects	8	Number of Distinct Non-Detects	1

Minimum Detect	0.48	Minimum Non-Detect	0.06
Maximum Detect	22.7	Maximum Non-Detect	0.06
Variance Detects	58.71	Percent Non-Detects	11.11%
Mean Detects	4.94	SD Detects	7.662
Median Detects	1.705	CV Detects	1.551
Skewness Detects	2.268	Kurtosis Detects	5.139
Mean of Logged Detects	0.779	SD of Logged Detects	1.285

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.638	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.395	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	4.398	KM Standard Error of Mean	2.469
KM SD	6.929	95% KM (BCA) UCL	8.704
95% KM (t) UCL	8.989	95% KM (Percentile Bootstrap) UCL	8.829
95% KM (z) UCL	8.459	95% KM Bootstrap t UCL	38.91
90% KM Chebyshev UCL	11.81	95% KM Chebyshev UCL	15.16
97.5% KM Chebyshev UCL	19.82	99% KM Chebyshev UCL	28.97

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.73	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.342	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.304	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.734	k star (bias corrected MLE)	0.542
Theta hat (MLE)	6.732	Theta star (bias corrected MLE)	9.115
nu hat (MLE)	11.74	nu star (bias corrected)	8.671
Mean (detects)	4.94		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	4.392
Maximum	22.7	Median	1.49
SD	7.353	CV	1.674
k hat (MLE)	0.49	k star (bias corrected MLE)	0.401
Theta hat (MLE)	8.955	Theta star (bias corrected MLE)	10.95
nu hat (MLE)	8.828	nu star (bias corrected)	7.219
Adjusted Level of Significance (β)	0.0231		
Approximate Chi Square Value (7.22, α)	2.291	Adjusted Chi Square Value (7.22, β)	1.751
95% Gamma Approximate UCL (use when n>=50)	13.84	95% Gamma Adjusted UCL (use when n<50)	18.1

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	4.398	SD (KM)	6.929
Variance (KM)	48.01	SE of Mean (KM)	2.469
k hat (KM)	0.403	k star (KM)	0.343
nu hat (KM)	7.251	nu star (KM)	6.167
theta hat (KM)	10.92	theta star (KM)	12.84
80% gamma percentile (KM)	6.937	90% gamma percentile (KM)	12.74
95% gamma percentile (KM)	19.26	99% gamma percentile (KM)	35.94

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (6.17, α)	1.726	Adjusted Chi Square Value (6.17, β)	1.278
95% Gamma Approximate KM-UCL (use when n>=50)	15.71	95% Gamma Adjusted KM-UCL (use when n<50)	21.22

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.263	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	4.402	Mean in Log Scale	0.432
SD in Original Scale	7.347	SD in Log Scale	1.59
95% t UCL (assumes normality of ROS data)	8.956	95% Percentile Bootstrap UCL	8.53
95% BCA Bootstrap UCL	11.02	95% Bootstrap t UCL	39.92
95% H-UCL (Log ROS)	75.3		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.38	KM Geo Mean	1.462
KM SD (logged)	1.6	95% Critical H Value (KM-Log)	4.692
KM Standard Error of Mean (logged)	0.57	95% H-UCL (KM -Log)	74.74
KM SD (logged)	1.6	95% Critical H Value (KM-Log)	4.692
KM Standard Error of Mean (logged)	0.57		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	4.394	Mean in Log Scale	0.303
SD in Original Scale	7.352	SD in Log Scale	1.867
95% t UCL (Assumes normality)	8.951	95% H-Stat UCL	267.2

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Bootstrap t UCL 38.91 | KM-UCL (use when k<=1 and 15 < n < 50 but k<=1) 21.22

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	94.8	Mean	3107
Maximum	12100	Median	1170
SD	3957	Std. Error of Mean	1319
Coefficient of Variation	1.274	Skewness	1.75

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.243	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5560	95% Adjusted-CLT UCL (Chen-1995)	6099
		95% Modified-t UCL (Johnson-1978)	5688

Gamma GOF Test

A-D Test Statistic	0.194	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.165	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.29	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.697	k star (bias corrected MLE)	0.539
Theta hat (MLE)	4457	Theta star (bias corrected MLE)	5767
nu hat (MLE)	12.55	nu star (bias corrected)	9.698
MLE Mean (bias corrected)	3107	MLE Sd (bias corrected)	4233
		Approximate Chi Square Value (0.05)	3.754
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	3.015

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	8027	95% Adjusted Gamma UCL (use when n<50)	9993

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.109	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.552	Mean of logged Data	7.174
Maximum of Logged Data	9.401	SD of logged Data	1.559

Assuming Lognormal Distribution

95% H-UCL	55288	90% Chebyshev (MVUE) UCL	9112
95% Chebyshev (MVUE) UCL	11655	97.5% Chebyshev (MVUE) UCL	15186
99% Chebyshev (MVUE) UCL	22121		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5277	95% Jackknife UCL	5560
95% Standard Bootstrap UCL	5120	95% Bootstrap-t UCL	8690
95% Hall's Bootstrap UCL	13648	95% Percentile Bootstrap UCL	5319
95% BCA Bootstrap UCL	5987		
90% Chebyshev(Mean, Sd) UCL	7064	95% Chebyshev(Mean, Sd) UCL	8857
97.5% Chebyshev(Mean, Sd) UCL	11344	99% Chebyshev(Mean, Sd) UCL	16231

Suggested UCL to Use

95% Student's-t UCL 5560

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	0.43	Mean	106.5
Maximum	838	Median	2.53
SD	258.9	Std. Error of Mean	78.05
Coefficient of Variation	2.431	Skewness	2.742

Normal GOF Test

Shapiro Wilk Test Statistic	0.489	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.46	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	247.9	95% Adjusted-CLT UCL (Chen-1995)	303.8
		95% Modified-t UCL (Johnson-1978)	258.7

Gamma GOF Test

A-D Test Statistic	1.692	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.843	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.36	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.279	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.243	k star (bias corrected MLE)	0.238
Theta hat (MLE)	437.7	Theta star (bias corrected MLE)	448.3
nu hat (MLE)	5.351	nu star (bias corrected)	5.225
MLE Mean (bias corrected)	106.5	MLE Sd (bias corrected)	218.5
		Approximate Chi Square Value (0.05)	1.258
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	0.971

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	442.4	95% Adjusted Gamma UCL (use when n<50)	572.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.242	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.251	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.844	Mean of logged Data	1.735
Maximum of Logged Data	6.731	SD of logged Data	2.398

Assuming Lognormal Distribution

95% H-UCL	10040	90% Chebyshev (MVUE) UCL	167.5
95% Chebyshev (MVUE) UCL	219.8	97.5% Chebyshev (MVUE) UCL	292.2
99% Chebyshev (MVUE) UCL	434.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	234.9	95% Jackknife UCL	247.9
95% Standard Bootstrap UCL	226.8	95% Bootstrap-t UCL	8237
95% Hall's Bootstrap UCL	7262	95% Percentile Bootstrap UCL	237.5
95% BCA Bootstrap UCL	308		
90% Chebyshev(Mean, Sd) UCL	340.6	95% Chebyshev(Mean, Sd) UCL	446.7
97.5% Chebyshev(Mean, Sd) UCL	593.9	99% Chebyshev(Mean, Sd) UCL	883.1

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL 883.1

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	14.4	Mean	163.1
Maximum	531	Median	121
SD	170.6	Std. Error of Mean	56.85
Coefficient of Variation	1.046	Skewness	1.528

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.818	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	268.8	95% Adjusted-CLT UCL (Chen-1995)	287.5
		95% Modified-t UCL (Johnson-1978)	273.6

Gamma GOF Test

A-D Test Statistic	0.29	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.169	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.287	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	1.036	k star (bias corrected MLE)	0.765
Theta hat (MLE)	157.4	Theta star (bias corrected MLE)	213.2
nu hat (MLE)	18.65	nu star (bias corrected)	13.77
MLE Mean (bias corrected)	163.1	MLE Sd (bias corrected)	186.5
		Approximate Chi Square Value (0.05)	6.412
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	5.39

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	350.1	95% Adjusted Gamma UCL (use when n<50)	416.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.944	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.204	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.667	Mean of logged Data	4.539
Maximum of Logged Data	6.275	SD of logged Data	1.212

Assuming Lognormal Distribution

95% H-UCL	964.2	90% Chebyshev (MVUE) UCL	391.4
95% Chebyshev (MVUE) UCL	490.2	97.5% Chebyshev (MVUE) UCL	627.3
99% Chebyshev (MVUE) UCL	896.7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	256.6	95% Jackknife UCL	268.8
95% Standard Bootstrap UCL	251.4	95% Bootstrap-t UCL	397.5
95% Hall's Bootstrap UCL	855.5	95% Percentile Bootstrap UCL	258.2
95% BCA Bootstrap UCL	277.1		
90% Chebyshev(Mean, Sd) UCL	333.6	95% Chebyshev(Mean, Sd) UCL	410.9
97.5% Chebyshev(Mean, Sd) UCL	518.1	99% Chebyshev(Mean, Sd) UCL	728.8

Suggested UCL to Use

95% Adjusted Gamma UCL	416.5

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Mercury (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	8.4700E-4	Mean	0.0142
Maximum	0.0936	Median	0.00201
SD	0.0304	Std. Error of Mean	0.0101
Coefficient of Variation	2.147	Skewness	2.78

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.504	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.421	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0331	95% Adjusted-CLT UCL (Chen-1995)	0.0409
		95% Modified-t UCL (Johnson-1978)	0.0346

Gamma GOF Test

A-D Test Statistic	1.528	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.776	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.409	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.295	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.47	k star (bias corrected MLE)	0.387
Theta hat (MLE)	0.0302	Theta star (bias corrected MLE)	0.0366
nu hat (MLE)	8.458	nu star (bias corrected)	6.972
MLE Mean (bias corrected)	0.0142	MLE Sd (bias corrected)	0.0228
		Approximate Chi Square Value (0.05)	2.155
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	1.636

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0459	95% Adjusted Gamma UCL (use when n<50)	0.0604

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.766	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.329	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.274	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-7.074	Mean of logged Data	-5.621
Maximum of Logged Data	-2.369	SD of logged Data	1.504

Assuming Lognormal Distribution

95% H-UCL	0.12	90% Chebyshev (MVUE) UCL	0.0233
95% Chebyshev (MVUE) UCL	0.0297	97.5% Chebyshev (MVUE) UCL	0.0386
99% Chebyshev (MVUE) UCL	0.056		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0309	95% Jackknife UCL	0.0331
95% Standard Bootstrap UCL	0.0295	95% Bootstrap-t UCL	0.686
95% Hall's Bootstrap UCL	0.311	95% Percentile Bootstrap UCL	0.0326
95% BCA Bootstrap UCL	0.0387		
90% Chebyshev(Mean, Sd) UCL	0.0446	95% Chebyshev(Mean, Sd) UCL	0.0584
97.5% Chebyshev(Mean, Sd) UCL	0.0776	99% Chebyshev(Mean, Sd) UCL	0.115

Suggested UCL to Use

95% Hall's Bootstrap UCL 0.311

Recommended UCL exceeds the maximum observation

In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.3	Mean	1.229
Maximum	3.58	Median	0.74
SD	1.079	Std. Error of Mean	0.36
Coefficient of Variation	0.878	Skewness	1.57

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.809	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.23	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	1.898	95% Adjusted-CLT UCL (Chen-1995)	2.022
		95% Modified-t UCL (Johnson-1978)	1.929

Gamma GOF Test

A-D Test Statistic	0.416	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.283	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.813	k star (bias corrected MLE)	1.283
Theta hat (MLE)	0.678	Theta star (bias corrected MLE)	0.958
nu hat (MLE)	32.63	nu star (bias corrected)	23.09
MLE Mean (bias corrected)	1.229	MLE Sd (bias corrected)	1.085
		Approximate Chi Square Value (0.05)	13.16
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	11.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.157	95% Adjusted Gamma UCL (use when n<50)	2.445

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.949	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.186	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.204	Mean of logged Data	-0.0944
Maximum of Logged Data	1.275	SD of logged Data	0.805

Assuming Lognormal Distribution

95% H-UCL	2.808	90% Chebyshev (MVUE) UCL	2.201
95% Chebyshev (MVUE) UCL	2.653	97.5% Chebyshev (MVUE) UCL	3.28
99% Chebyshev (MVUE) UCL	4.511		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.821	95% Jackknife UCL	1.898
95% Standard Bootstrap UCL	1.792	95% Bootstrap-t UCL	2.681
95% Hall's Bootstrap UCL	4.67	95% Percentile Bootstrap UCL	1.81
95% BCA Bootstrap UCL	1.999		
90% Chebyshev(Mean, Sd) UCL	2.308	95% Chebyshev(Mean, Sd) UCL	2.797
97.5% Chebyshev(Mean, Sd) UCL	3.476	99% Chebyshev(Mean, Sd) UCL	4.809

Suggested UCL to Use

95% Student's-t UCL	1.898

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vanadium (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
		Number of Missing Observations	0
Minimum	0.31	Mean	1.503
Maximum	5.05	Median	1.27
SD	1.555	Std. Error of Mean	0.518
Coefficient of Variation	1.034	Skewness	1.75

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.787	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.256	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.467	95% Adjusted-CLT UCL (Chen-1995)	2.679
		95% Modified-t UCL (Johnson-1978)	2.517

Gamma GOF Test

A-D Test Statistic	0.414	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.203	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.285	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.271	k star (bias corrected MLE)	0.921
Theta hat (MLE)	1.183	Theta star (bias corrected MLE)	1.632
nu hat (MLE)	22.87	nu star (bias corrected)	16.58
MLE Mean (bias corrected)	1.503	MLE Sd (bias corrected)	1.566
		Approximate Chi Square Value (0.05)	8.374
Adjusted Level of Significance	0.0231	Adjusted Chi Square Value	7.179

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.977	95% Adjusted Gamma UCL (use when n<50)	3.473

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.917	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.176	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.274	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.171	Mean of logged Data	-0.0348
Maximum of Logged Data	1.619	SD of logged Data	1.002

Assuming Lognormal Distribution

95% H-UCL	5.034	90% Chebyshev (MVUE) UCL	3.02
95% Chebyshev (MVUE) UCL	3.717	97.5% Chebyshev (MVUE) UCL	4.684
99% Chebyshev (MVUE) UCL	6.583		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.356	95% Jackknife UCL	2.467
95% Standard Bootstrap UCL	2.311	95% Bootstrap-t UCL	3.445
95% Hall's Bootstrap UCL	6.699	95% Percentile Bootstrap UCL	2.359
95% BCA Bootstrap UCL	2.613		
90% Chebyshev(Mean, Sd) UCL	3.058	95% Chebyshev(Mean, Sd) UCL	3.762
97.5% Chebyshev(Mean, Sd) UCL	4.739	99% Chebyshev(Mean, Sd) UCL	6.659

Suggested UCL to Use

95% Student's-t UCL 2.467

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	11	Number of Distinct Observations	11
		Number of Missing Observations	0
Minimum	17.5	Mean	306.5
Maximum	1840	Median	47.8
SD	560.5	Std. Error of Mean	169
Coefficient of Variation	1.829	Skewness	2.481

Normal GOF Test

Shapiro Wilk Test Statistic	0.596	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.349	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Data Not Normal at 5% Significance Level

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	612.8	95% Adjusted-CLT UCL (Chen-1995)	719.6
		95% Modified-t UCL (Johnson-1978)	633.9

Gamma GOF Test

A-D Test Statistic	1.072	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.781	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.323	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.269	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.506	k star (bias corrected MLE)	0.429
Theta hat (MLE)	605.4	Theta star (bias corrected MLE)	714.8
nu hat (MLE)	11.14	nu star (bias corrected)	9.434
MLE Mean (bias corrected)	306.5	MLE Sd (bias corrected)	468.1
		Approximate Chi Square Value (0.05)	3.591
Adjusted Level of Significance	0.0278	Adjusted Chi Square Value	3.028

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	805.2	95% Adjusted Gamma UCL (use when n<50)	955.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.869	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.85	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.271	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.251	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.862	Mean of logged Data	4.473
Maximum of Logged Data	7.518	SD of logged Data	1.569

Assuming Lognormal Distribution

95% H-UCL	2392	90% Chebyshev (MVUE) UCL	621.7
95% Chebyshev (MVUE) UCL	791.9	97.5% Chebyshev (MVUE) UCL	1028
99% Chebyshev (MVUE) UCL	1492		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	584.5	95% Jackknife UCL	612.8
95% Standard Bootstrap UCL	571.8	95% Bootstrap-t UCL	1587
95% Hall's Bootstrap UCL	1712	95% Percentile Bootstrap UCL	581.9
95% BCA Bootstrap UCL	758.7		
90% Chebyshev(Mean, Sd) UCL	813.5	95% Chebyshev(Mean, Sd) UCL	1043
97.5% Chebyshev(Mean, Sd) UCL	1362	99% Chebyshev(Mean, Sd) UCL	1988

Appendix D. Table 23. ProUCL Output - Aquatic Plants as Salve
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL 1988

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 2:16:18 PM
From File	TCOU5 ProUCL Tables 190506_k.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	11
Number of Detects	9	Number of Non-Detects	5
Number of Distinct Detects	9	Number of Distinct Non-Detects	2
Minimum Detect	0.67	Minimum Non-Detect	0.63
Maximum Detect	10.4	Maximum Non-Detect	0.64
Variance Detects	10.57	Percent Non-Detects	35.71%
Mean Detects	4.016	SD Detects	3.251
Median Detects	3.1	CV Detects	0.81
Skewness Detects	1.288	Kurtosis Detects	0.736
Mean of Logged Detects	1.094	SD of Logged Detects	0.85

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.269	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.806	KM Standard Error of Mean	0.835
KM SD	2.945	95% KM (BCA) UCL	4.185
95% KM (t) UCL	4.285	95% KM (Percentile Bootstrap) UCL	4.214
95% KM (z) UCL	4.179	95% KM Bootstrap t UCL	5.704
90% KM Chebyshev UCL	5.311	95% KM Chebyshev UCL	6.445
97.5% KM Chebyshev UCL	8.019	99% KM Chebyshev UCL	11.11

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.302	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.189	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.283	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.835	k star (bias corrected MLE)	1.297
Theta hat (MLE)	2.188	Theta star (bias corrected MLE)	3.095
nu hat (MLE)	33.03	nu star (bias corrected)	23.35
Mean (detects)	4.016		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.585
Maximum	10.4	Median	1.77
SD	3.236	CV	1.252
k hat (MLE)	0.355	k star (bias corrected MLE)	0.326
Theta hat (MLE)	7.287	Theta star (bias corrected MLE)	7.921
nu hat (MLE)	9.933	nu star (bias corrected)	9.138
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (9.14, α)	3.41	Adjusted Chi Square Value (9.14, β)	2.962
95% Gamma Approximate UCL (use when n>=50)	6.926	95% Gamma Adjusted UCL (use when n<50)	7.976

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.806	SD (KM)	2.945
Variance (KM)	8.671	SE of Mean (KM)	0.835
k hat (KM)	0.908	k star (KM)	0.761
nu hat (KM)	25.43	nu star (KM)	21.32
theta hat (KM)	3.09	theta star (KM)	3.686
80% gamma percentile (KM)	4.598	90% gamma percentile (KM)	6.906
95% gamma percentile (KM)	9.268	99% gamma percentile (KM)	14.87

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (21.32, α)	11.83	Adjusted Chi Square Value (21.32, β)	10.9
95% Gamma Approximate KM-UCL (use when n>=50)	5.058	95% Gamma Adjusted KM-UCL (use when n<50)	5.489

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.153	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.716	Mean in Log Scale	0.322
SD in Original Scale	3.129	SD in Log Scale	1.292
95% t UCL (assumes normality of ROS data)	4.196	95% Percentile Bootstrap UCL	4.121
95% BCA Bootstrap UCL	4.43	95% Bootstrap t UCL	5.442
95% H-UCL (Log ROS)	10.4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.538	KM Geo Mean	1.713
KM SD (logged)	0.984	95% Critical H Value (KM-Log)	2.766
KM Standard Error of Mean (logged)	0.279	95% H-UCL (KM -Log)	5.915
KM SD (logged)	0.984	95% Critical H Value (KM-Log)	2.766
KM Standard Error of Mean (logged)	0.279		

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.694	Mean in Log Scale	0.292
SD in Original Scale	3.145	SD in Log Scale	1.301
95% t UCL (Assumes normality)	4.183	95% H-Stat UCL	10.32

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 4.285

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	4
Number of Detects	3	Number of Non-Detects	11
Number of Distinct Detects	3	Number of Distinct Non-Detects	1
Minimum Detect	0.28	Minimum Non-Detect	0.27
Maximum Detect	0.55	Maximum Non-Detect	0.27
Variance Detects	0.0201	Percent Non-Detects	78.57%
Mean Detects	0.39	SD Detects	0.142
Median Detects	0.34	CV Detects	0.364
Skewness Detects	1.39	Kurtosis Detects	N/A
Mean of Logged Detects	-0.983	SD of Logged Detects	0.348

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.907	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.304	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.296	KM Standard Error of Mean	0.0238
KM SD	0.0728	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.338	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.335	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.367	95% KM Chebyshev UCL	0.4
97.5% KM Chebyshev UCL	0.444	99% KM Chebyshev UCL	0.533

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	12.18	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.032	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	73.11	nu star (bias corrected)	N/A
Mean (detects)	0.39		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0984
Maximum	0.55	Median	0.01
SD	0.169	CV	1.717
k hat (MLE)	0.493	k star (bias corrected MLE)	0.435
Theta hat (MLE)	0.199	Theta star (bias corrected MLE)	0.226
nu hat (MLE)	13.82	nu star (bias corrected)	12.19
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (12.19, α)	5.353	Adjusted Chi Square Value (12.19, β)	4.765
95% Gamma Approximate UCL (use when n>=50)	0.224	95% Gamma Adjusted UCL (use when n<50)	N/A

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.296	SD (KM)	0.0728
Variance (KM)	0.0053	SE of Mean (KM)	0.0238
k hat (KM)	16.51	k star (KM)	13.02
nu hat (KM)	462.3	nu star (KM)	364.6
theta hat (KM)	0.0179	theta star (KM)	0.0227
80% gamma percentile (KM)	0.362	90% gamma percentile (KM)	0.404
95% gamma percentile (KM)	0.442	99% gamma percentile (KM)	0.519

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (364.60, α)	321.3	Adjusted Chi Square Value (364.60, β)	316
95% Gamma Approximate KM-UCL (use when n>=50)	0.336	95% Gamma Adjusted KM-UCL (use when n<50)	0.341

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.275	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.145	Mean in Log Scale	-2.387
SD in Original Scale	0.151	SD in Log Scale	1
95% t UCL (assumes normality of ROS data)	0.216	95% Percentile Bootstrap UCL	0.21
95% BCA Bootstrap UCL	0.231	95% Bootstrap t UCL	0.269
95% H-UCL (Log ROS)	0.329		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.239	KM Geo Mean	0.29
KM SD (logged)	0.188	95% Critical H Value (KM-Log)	1.81
KM Standard Error of Mean (logged)	0.0614	95% H-UCL (KM -Log)	0.324
KM SD (logged)	0.188	95% Critical H Value (KM-Log)	1.81
KM Standard Error of Mean (logged)	0.0614		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.19	Mean in Log Scale	-1.784
SD in Original Scale	0.122	SD in Log Scale	0.455
95% t UCL (Assumes normality)	0.247	95% H-Stat UCL	0.24

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.338

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Barium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	1.09	Mean	3.771
Maximum	5.72	Median	4.075
SD	1.507	Std. Error of Mean	0.403
Coefficient of Variation	0.4	Skewness	-0.73

Normal GOF Test

Shapiro Wilk Test Statistic	0.908	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.198	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.485	95% Adjusted-CLT UCL (Chen-1995)	4.35
		95% Modified-t UCL (Johnson-1978)	4.471

Gamma GOF Test

A-D Test Statistic	0.954	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.739	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.262	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.685	k star (bias corrected MLE)	3.729
Theta hat (MLE)	0.805	Theta star (bias corrected MLE)	1.011
nu hat (MLE)	131.2	nu star (bias corrected)	104.4
MLE Mean (bias corrected)	3.771	MLE Sd (bias corrected)	1.953
		Approximate Chi Square Value (0.05)	81.83
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	79.19

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.812	95% Adjusted Gamma UCL (use when n<50)	4.973

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.81	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.283	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0862	Mean of logged Data	1.217
Maximum of Logged Data	1.744	SD of logged Data	0.543

Assuming Lognormal Distribution

95% H-UCL	5.343	90% Chebyshev (MVUE) UCL	5.604
95% Chebyshev (MVUE) UCL	6.39	97.5% Chebyshev (MVUE) UCL	7.482
99% Chebyshev (MVUE) UCL	9.627		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.434	95% Jackknife UCL	4.485
95% Standard Bootstrap UCL	4.417	95% Bootstrap-t UCL	4.431
95% Hall's Bootstrap UCL	4.346	95% Percentile Bootstrap UCL	4.376
95% BCA Bootstrap UCL	4.352		
90% Chebyshev(Mean, Sd) UCL	4.979	95% Chebyshev(Mean, Sd) UCL	5.527
97.5% Chebyshev(Mean, Sd) UCL	6.286	99% Chebyshev(Mean, Sd) UCL	7.778

Suggested UCL to Use

95% Student's-t UCL 4.485

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Beryllium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	2
Number of Detects	2	Number of Non-Detects	12
Number of Distinct Detects	2	Number of Distinct Non-Detects	1
Minimum Detect	0.01	Minimum Non-Detect	0.01
Maximum Detect	0.02	Maximum Non-Detect	0.01
Variance Detects	5.0000E-5	Percent Non-Detects	85.71%
Mean Detects	0.015	SD Detects	0.00707
Median Detects	0.015	CV Detects	0.471
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-4.259	SD of Logged Detects	0.49

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0107	KM Standard Error of Mean	9.7341E-4
KM SD	0.00258	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0124	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0123	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0136	95% KM Chebyshev UCL	0.015
97.5% KM Chebyshev UCL	0.0168	99% KM Chebyshev UCL	0.0204

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	8.653	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00173	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	34.61	nu star (bias corrected)	N/A
Mean (detects)	0.015		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0107	SD (KM)	0.00258
Variance (KM)	6.6327E-6	SE of Mean (KM)	9.7341E-4
k hat (KM)	17.31	k star (KM)	13.65
nu hat (KM)	484.6	nu star (KM)	382.1
theta hat (KM)	6.1905E-4	theta star (KM)	7.8513E-4
80% gamma percentile (KM)	0.013	90% gamma percentile (KM)	0.0146
95% gamma percentile (KM)	0.0159	99% gamma percentile (KM)	0.0186

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0312
Approximate Chi Square Value (382.10, α)	337.8	Adjusted Chi Square Value (382.10, β)	332.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.0121	95% Gamma Adjusted KM-UCL (use when n<50)	0.0123

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00302	Mean in Log Scale	-7.104
SD in Original Scale	0.00554	SD in Log Scale	1.747
95% t UCL (assumes normality of ROS data)	0.00565	95% Percentile Bootstrap UCL	0.00559
95% BCA Bootstrap UCL	0.0068	95% Bootstrap t UCL	0.0139
95% H-UCL (Log ROS)	0.0285		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.556	KM Geo Mean	0.0105
KM SD (logged)	0.179	95% Critical H Value (KM-Log)	1.803
KM Standard Error of Mean (logged)	0.0675	95% H-UCL (KM -Log)	0.0117
KM SD (logged)	0.179	95% Critical H Value (KM-Log)	1.803
KM Standard Error of Mean (logged)	0.0675		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.00643	Mean in Log Scale	-5.15
SD in Original Scale	0.00413	SD in Log Scale	0.401
95% t UCL (Assumes normality)	0.00838	95% H-Stat UCL	0.00784

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0124	KM H-UCL	0.0117
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	6
Number of Detects	10	Number of Non-Detects	4
Number of Distinct Detects	6	Number of Distinct Non-Detects	1
Minimum Detect	0.03	Minimum Non-Detect	0.03
Maximum Detect	0.1	Maximum Non-Detect	0.03
Variance Detects	5.1556E-4	Percent Non-Detects	28.57%
Mean Detects	0.056	SD Detects	0.0227
Median Detects	0.05	CV Detects	0.405
Skewness Detects	1.119	Kurtosis Detects	0.375
Mean of Logged Detects	-2.949	SD of Logged Detects	0.377

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.23	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data appear Normal at 5% Significance Level	

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0486	KM Standard Error of Mean	0.0061
KM SD	0.0217	95% KM (BCA) UCL	0.0586
95% KM (t) UCL	0.0594	95% KM (Percentile Bootstrap) UCL	0.0586
95% KM (z) UCL	0.0586	95% KM Bootstrap t UCL	0.0656
90% KM Chebyshev UCL	0.0669	95% KM Chebyshev UCL	0.0752
97.5% KM Chebyshev UCL	0.0867	99% KM Chebyshev UCL	0.109

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.458	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.727	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.177	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.267	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.648	k star (bias corrected MLE)	5.42
Theta hat (MLE)	0.00732	Theta star (bias corrected MLE)	0.0103
nu hat (MLE)	153	nu star (bias corrected)	108.4
Mean (detects)	0.056		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0437
Maximum	0.1	Median	0.04
SD	0.0277	CV	0.633
k hat (MLE)	2.357	k star (bias corrected MLE)	1.9
Theta hat (MLE)	0.0185	Theta star (bias corrected MLE)	0.023
nu hat (MLE)	66	nu star (bias corrected)	53.19
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (53.19, α)	37.44	Adjusted Chi Square Value (53.19, β)	35.69
95% Gamma Approximate UCL (use when n>=50)	0.0621	95% Gamma Adjusted UCL (use when n<50)	0.0652

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0486	SD (KM)	0.0217
Variance (KM)	4.6939E-4	SE of Mean (KM)	0.0061
k hat (KM)	5.026	k star (KM)	3.997
nu hat (KM)	140.7	nu star (KM)	111.9
theta hat (KM)	0.00966	theta star (KM)	0.0122
80% gamma percentile (KM)	0.067	90% gamma percentile (KM)	0.0811
95% gamma percentile (KM)	0.0942	99% gamma percentile (KM)	0.122

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (111.91, α)	88.49	Adjusted Chi Square Value (111.91, β)	85.73
95% Gamma Approximate KM-UCL (use when n>=50)	0.0614	95% Gamma Adjusted KM-UCL (use when n<50)	0.0634

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.163	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0459	Mean in Log Scale	-3.218
SD in Original Scale	0.0252	SD in Log Scale	0.552
95% t UCL (assumes normality of ROS data)	0.0579	95% Percentile Bootstrap UCL	0.057
95% BCA Bootstrap UCL	0.0588	95% Bootstrap t UCL	0.0622
95% H-UCL (Log ROS)	0.0642		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.108	KM Geo Mean	0.0447
KM SD (logged)	0.394	95% Critical H Value (KM-Log)	1.978
KM Standard Error of Mean (logged)	0.111	95% H-UCL (KM -Log)	0.0599
KM SD (logged)	0.394	95% Critical H Value (KM-Log)	1.978
KM Standard Error of Mean (logged)	0.111		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0443	Mean in Log Scale	-3.306
SD in Original Scale	0.027	SD in Log Scale	0.665
95% t UCL (Assumes normality)	0.057	95% H-Stat UCL	0.0698

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0594

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	6
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	0.08	Minimum Non-Detect	0.06
Maximum Detect	1.05	Maximum Non-Detect	0.06
Variance Detects	0.108	Percent Non-Detects	42.86%
Mean Detects	0.476	SD Detects	0.329
Median Detects	0.535	CV Detects	0.69
Skewness Detects	0.395	Kurtosis Detects	-0.347
Mean of Logged Detects	-1.037	SD of Logged Detects	0.909

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.298	KM Standard Error of Mean	0.0888
KM SD	0.311	95% KM (BCA) UCL	0.444
95% KM (t) UCL	0.455	95% KM (Percentile Bootstrap) UCL	0.44
95% KM (z) UCL	0.444	95% KM Bootstrap t UCL	0.491
90% KM Chebyshev UCL	0.564	95% KM Chebyshev UCL	0.685
97.5% KM Chebyshev UCL	0.852	99% KM Chebyshev UCL	1.181

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.443	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.725	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.227	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.298	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.843	k star (bias corrected MLE)	1.235
Theta hat (MLE)	0.258	Theta star (bias corrected MLE)	0.386
nu hat (MLE)	29.48	nu star (bias corrected)	19.76
Mean (detects)	0.476		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.276
Maximum	1.05	Median	0.11
SD	0.34	CV	1.23
k hat (MLE)	0.497	k star (bias corrected MLE)	0.438
Theta hat (MLE)	0.557	Theta star (bias corrected MLE)	0.631
nu hat (MLE)	13.9	nu star (bias corrected)	12.26
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (12.26, α)	5.398	Adjusted Chi Square Value (12.26, β)	4.807
95% Gamma Approximate UCL (use when n>=50)	0.628	95% Gamma Adjusted UCL (use when n<50)	0.705

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.298	SD (KM)	0.311
Variance (KM)	0.0965	SE of Mean (KM)	0.0888
k hat (KM)	0.919	k star (KM)	0.77
nu hat (KM)	25.74	nu star (KM)	21.56
theta hat (KM)	0.324	theta star (KM)	0.387
80% gamma percentile (KM)	0.488	90% gamma percentile (KM)	0.731
95% gamma percentile (KM)	0.98	99% gamma percentile (KM)	1.569

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (21.56, α)	12.01	Adjusted Chi Square Value (21.56, β)	11.07
95% Gamma Approximate KM-UCL (use when n>=50)	0.535	95% Gamma Adjusted KM-UCL (use when n<50)	0.58

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.256	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.289	Mean in Log Scale	-2.053
SD in Original Scale	0.33	SD in Log Scale	1.455
95% t UCL (assumes normality of ROS data)	0.445	95% Percentile Bootstrap UCL	0.432
95% BCA Bootstrap UCL	0.456	95% Bootstrap t UCL	0.502
95% H-UCL (Log ROS)	1.586		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.798	KM Geo Mean	0.166
KM SD (logged)	1.089	95% Critical H Value (KM-Log)	2.941
KM Standard Error of Mean (logged)	0.311	95% H-UCL (KM -Log)	0.728
KM SD (logged)	1.089	95% Critical H Value (KM-Log)	2.941
KM Standard Error of Mean (logged)	0.311		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.285	Mean in Log Scale	-2.095
SD in Original Scale	0.333	SD in Log Scale	1.433
95% t UCL (Assumes normality)	0.443	95% H-Stat UCL	1.415

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.455

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
Number of Detects	8	Number of Non-Detects	6
Number of Distinct Detects	8	Number of Distinct Non-Detects	5

Minimum Detect	0.34	Minimum Non-Detect	0.18
Maximum Detect	1.2	Maximum Non-Detect	0.54
Variance Detects	0.0768	Percent Non-Detects	42.86%
Mean Detects	0.609	SD Detects	0.277
Median Detects	0.555	CV Detects	0.455
Skewness Detects	1.524	Kurtosis Detects	2.758
Mean of Logged Detects	-0.575	SD of Logged Detects	0.411

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.859	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.433	KM Standard Error of Mean	0.0823
KM SD	0.286	95% KM (BCA) UCL	0.574
95% KM (t) UCL	0.578	95% KM (Percentile Bootstrap) UCL	0.563
95% KM (z) UCL	0.568	95% KM Bootstrap t UCL	0.6
90% KM Chebyshev UCL	0.679	95% KM Chebyshev UCL	0.791
97.5% KM Chebyshev UCL	0.946	99% KM Chebyshev UCL	1.251

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.296	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.718	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.159	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.295	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.556	k star (bias corrected MLE)	4.181
Theta hat (MLE)	0.0928	Theta star (bias corrected MLE)	0.146
nu hat (MLE)	104.9	nu star (bias corrected)	66.9
Mean (detects)	0.609		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.384
Maximum	1.2	Median	0.36
SD	0.34	CV	0.885
k hat (MLE)	0.995	k star (bias corrected MLE)	0.83
Theta hat (MLE)	0.386	Theta star (bias corrected MLE)	0.463
nu hat (MLE)	27.86	nu star (bias corrected)	23.23
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (23.23, α)	13.26	Adjusted Chi Square Value (23.23, β)	12.27
95% Gamma Approximate UCL (use when n>=50)	0.673	95% Gamma Adjusted UCL (use when n<50)	0.727

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.433	SD (KM)	0.286
Variance (KM)	0.0816	SE of Mean (KM)	0.0823
k hat (KM)	2.293	k star (KM)	1.849
nu hat (KM)	64.19	nu star (KM)	51.77
theta hat (KM)	0.189	theta star (KM)	0.234
80% gamma percentile (KM)	0.654	90% gamma percentile (KM)	0.857
95% gamma percentile (KM)	1.052	99% gamma percentile (KM)	1.487

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (51.77, α)	36.24	Adjusted Chi Square Value (51.77, β)	34.53
95% Gamma Approximate KM-UCL (use when n>=50)	0.618	95% Gamma Adjusted KM-UCL (use when n<50)	0.649

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.149	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.441	Mean in Log Scale	-0.986
SD in Original Scale	0.287	SD in Log Scale	0.588
95% t UCL (assumes normality of ROS data)	0.577	95% Percentile Bootstrap UCL	0.563
95% BCA Bootstrap UCL	0.598	95% Bootstrap t UCL	0.642
95% H-UCL (Log ROS)	0.632		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.037	KM Geo Mean	0.355
KM SD (logged)	0.625	95% Critical H Value (KM-Log)	2.245
KM Standard Error of Mean (logged)	0.182	95% H-UCL (KM -Log)	0.636
KM SD (logged)	0.625	95% Critical H Value (KM-Log)	2.245
KM Standard Error of Mean (logged)	0.182		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.41	Mean in Log Scale	-1.194
SD in Original Scale	0.316	SD in Log Scale	0.845
95% t UCL (Assumes normality)	0.559	95% H-Stat UCL	0.787

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.578

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Iron (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	3.57	Mean	6.394
Maximum	13.2	Median	5.23
SD	3.141	Std. Error of Mean	0.839
Coefficient of Variation	0.491	Skewness	1.41

Normal GOF Test

Shapiro Wilk Test Statistic	0.795	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.257	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7.881	95% Adjusted-CLT UCL (Chen-1995)	8.113
		95% Modified-t UCL (Johnson-1978)	7.933

Gamma GOF Test

A-D Test Statistic	0.812	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.197	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.229	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.587	k star (bias corrected MLE)	4.437
Theta hat (MLE)	1.145	Theta star (bias corrected MLE)	1.441
nu hat (MLE)	156.4	nu star (bias corrected)	124.2
MLE Mean (bias corrected)	6.394	MLE Sd (bias corrected)	3.036
		Approximate Chi Square Value (0.05)	99.5
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	96.56

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	7.984	95% Adjusted Gamma UCL (use when n<50)	8.227

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.18	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.273	Mean of logged Data	1.763
Maximum of Logged Data	2.58	SD of logged Data	0.425

Assuming Lognormal Distribution

95% H-UCL	8.078	90% Chebyshev (MVUE) UCL	8.545
95% Chebyshev (MVUE) UCL	9.545	97.5% Chebyshev (MVUE) UCL	10.93
99% Chebyshev (MVUE) UCL	13.66		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.775	95% Jackknife UCL	7.881
95% Standard Bootstrap UCL	7.753	95% Bootstrap-t UCL	8.485
95% Hall's Bootstrap UCL	8.346	95% Percentile Bootstrap UCL	7.841
95% BCA Bootstrap UCL	8.006		
90% Chebyshev(Mean, Sd) UCL	8.912	95% Chebyshev(Mean, Sd) UCL	10.05
97.5% Chebyshev(Mean, Sd) UCL	11.64	99% Chebyshev(Mean, Sd) UCL	14.75

Suggested UCL to Use

95% Adjusted Gamma UCL 8.227

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	10
Number of Detects	9	Number of Non-Detects	5
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	0.28	Minimum Non-Detect	0.24
Maximum Detect	1.92	Maximum Non-Detect	0.24
Variance Detects	0.296	Percent Non-Detects	35.71%
Mean Detects	0.676	SD Detects	0.544
Median Detects	0.48	CV Detects	0.805
Skewness Detects	1.937	Kurtosis Detects	3.215
Mean of Logged Detects	-0.599	SD of Logged Detects	0.626

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.703	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.39	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.52	KM Standard Error of Mean	0.131
KM SD	0.461	95% KM (BCA) UCL	0.76
95% KM (t) UCL	0.751	95% KM (Percentile Bootstrap) UCL	0.737
95% KM (z) UCL	0.735	95% KM Bootstrap t UCL	1.33
90% KM Chebyshev UCL	0.912	95% KM Chebyshev UCL	1.09
97.5% KM Chebyshev UCL	1.336	99% KM Chebyshev UCL	1.821

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.921	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.728	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.353	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.282	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.575	k star (bias corrected MLE)	1.791
Theta hat (MLE)	0.262	Theta star (bias corrected MLE)	0.377
nu hat (MLE)	46.35	nu star (bias corrected)	32.24
Mean (detects)	0.676		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.438
Maximum	1.92	Median	0.36
SD	0.54	CV	1.233
k hat (MLE)	0.524	k star (bias corrected MLE)	0.459
Theta hat (MLE)	0.836	Theta star (bias corrected MLE)	0.953
nu hat (MLE)	14.67	nu star (bias corrected)	12.86
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (12.86, α)	5.798	Adjusted Chi Square Value (12.86, β)	5.181
95% Gamma Approximate UCL (use when n>=50)	0.971	95% Gamma Adjusted UCL (use when n<50)	1.087

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.52	SD (KM)	0.461
Variance (KM)	0.213	SE of Mean (KM)	0.131
k hat (KM)	1.272	k star (KM)	1.047
nu hat (KM)	35.61	nu star (KM)	29.31
theta hat (KM)	0.409	theta star (KM)	0.497
80% gamma percentile (KM)	0.834	90% gamma percentile (KM)	1.184
95% gamma percentile (KM)	1.533	99% gamma percentile (KM)	2.34

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (29.31, α)	17.95	Adjusted Chi Square Value (29.31, β)	16.78
95% Gamma Approximate KM-UCL (use when n>=50)	0.849	95% Gamma Adjusted KM-UCL (use when n<50)	0.908

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.849	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.313	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.477	Mean in Log Scale	-1.168
SD in Original Scale	0.509	SD in Log Scale	0.962
95% t UCL (assumes normality of ROS data)	0.718	95% Percentile Bootstrap UCL	0.701
95% BCA Bootstrap UCL	0.764	95% Bootstrap t UCL	1.088
95% H-UCL (Log ROS)	1.023		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.895	KM Geo Mean	0.409
KM SD (logged)	0.618	95% Critical H Value (KM-Log)	2.234
KM Standard Error of Mean (logged)	0.175	95% H-UCL (KM -Log)	0.725
KM SD (logged)	0.618	95% Critical H Value (KM-Log)	2.234
KM Standard Error of Mean (logged)	0.175		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.477	Mean in Log Scale	-1.142
SD in Original Scale	0.508	SD in Log Scale	0.902
95% t UCL (Assumes normality)	0.718	95% H-Stat UCL	0.927

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	0.725

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	1.08	Mean	3.171
Maximum	7.11	Median	2.755
SD	1.813	Std. Error of Mean	0.485
Coefficient of Variation	0.572	Skewness	0.856

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.03	95% Adjusted-CLT UCL (Chen-1995)	4.087
		95% Modified-t UCL (Johnson-1978)	4.048

Gamma GOF Test

A-D Test Statistic	0.216	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.126	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.23	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.32	k star (bias corrected MLE)	2.657
Theta hat (MLE)	0.955	Theta star (bias corrected MLE)	1.194
nu hat (MLE)	92.97	nu star (bias corrected)	74.38
MLE Mean (bias corrected)	3.171	MLE Sd (bias corrected)	1.946
		Approximate Chi Square Value (0.05)	55.52
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	53.36

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.249	95% Adjusted Gamma UCL (use when n<50)	4.421

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.132	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.077	Mean of logged Data	0.996
Maximum of Logged Data	1.962	SD of logged Data	0.598

Assuming Lognormal Distribution

95% H-UCL	4.668	90% Chebyshev (MVUE) UCL	4.783
95% Chebyshev (MVUE) UCL	5.503	97.5% Chebyshev (MVUE) UCL	6.503
99% Chebyshev (MVUE) UCL	8.468		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.969	95% Jackknife UCL	4.03
95% Standard Bootstrap UCL	3.95	95% Bootstrap-t UCL	4.255
95% Hall's Bootstrap UCL	4.214	95% Percentile Bootstrap UCL	3.958
95% BCA Bootstrap UCL	4.046		
90% Chebyshev(Mean, Sd) UCL	4.625	95% Chebyshev(Mean, Sd) UCL	5.284
97.5% Chebyshev(Mean, Sd) UCL	6.198	99% Chebyshev(Mean, Sd) UCL	7.994

Suggested UCL to Use

95% Student's-t UCL 4.03

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	0.00297	Mean	0.0146
Maximum	0.0238	Median	0.0153
SD	0.0056	Std. Error of Mean	0.0015
Coefficient of Variation	0.382	Skewness	-0.45

Normal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.205	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0173	95% Adjusted-CLT UCL (Chen-1995)	0.0169
		95% Modified-t UCL (Johnson-1978)	0.0173

Gamma GOF Test

A-D Test Statistic	0.801	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.738	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.274	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.229	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.006	k star (bias corrected MLE)	3.981
Theta hat (MLE)	0.00292	Theta star (bias corrected MLE)	0.00368
nu hat (MLE)	140.2	nu star (bias corrected)	111.5
MLE Mean (bias corrected)	0.0146	MLE Sd (bias corrected)	0.00734
		Approximate Chi Square Value (0.05)	88.1
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	85.35

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0185	95% Adjusted Gamma UCL (use when n<50)	0.0191

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.806	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.302	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.226	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-5.819	Mean of logged Data	-4.327
Maximum of Logged Data	-3.738	SD of logged Data	0.539

Assuming Lognormal Distribution

95% H-UCL	0.0208	90% Chebyshev (MVUE) UCL	0.0218
95% Chebyshev (MVUE) UCL	0.0249	97.5% Chebyshev (MVUE) UCL	0.0291
99% Chebyshev (MVUE) UCL	0.0374		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0171	95% Jackknife UCL	0.0173
95% Standard Bootstrap UCL	0.017	95% Bootstrap-t UCL	0.0171
95% Hall's Bootstrap UCL	0.0171	95% Percentile Bootstrap UCL	0.0169
95% BCA Bootstrap UCL	0.0167		
90% Chebyshev(Mean, Sd) UCL	0.0191	95% Chebyshev(Mean, Sd) UCL	0.0212
97.5% Chebyshev(Mean, Sd) UCL	0.024	99% Chebyshev(Mean, Sd) UCL	0.0295

Suggested UCL to Use

95% Student's-t UCL 0.0173

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Nickel (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	3
Number of Detects	2	Number of Non-Detects	12
Number of Distinct Detects	2	Number of Distinct Non-Detects	1

Minimum Detect	0.1	Minimum Non-Detect	0.07
Maximum Detect	0.13	Maximum Non-Detect	0.07
Variance Detects	4.5000E-4	Percent Non-Detects	85.71%
Mean Detects	0.115	SD Detects	0.0212
Median Detects	0.115	CV Detects	0.184
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-2.171	SD of Logged Detects	0.186

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0764	KM Standard Error of Mean	0.00633
KM SD	0.0167	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.0876	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.0868	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.0954	95% KM Chebyshev UCL	0.104
97.5% KM Chebyshev UCL	0.116	99% KM Chebyshev UCL	0.139

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	58.44	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00197	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	233.8	nu star (bias corrected)	N/A
Mean (detects)	0.115		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0764	SD (KM)	0.0167
Variance (KM)	2.8010E-4	SE of Mean (KM)	0.00633
k hat (KM)	20.85	k star (KM)	16.43
nu hat (KM)	583.9	nu star (KM)	460.1
theta hat (KM)	0.00366	theta star (KM)	0.00465
80% gamma percentile (KM)	0.0917	90% gamma percentile (KM)	0.101
95% gamma percentile (KM)	0.11	99% gamma percentile (KM)	0.127

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0312
Approximate Chi Square Value (460.13, α)	411.4	Adjusted Chi Square Value (460.13, β)	405.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.0855	95% Gamma Adjusted KM-UCL (use when n<50)	0.0868

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0476	Mean in Log Scale	-3.249
SD in Original Scale	0.0333	SD in Log Scale	0.661
95% t UCL (assumes normality of ROS data)	0.0634	95% Percentile Bootstrap UCL	0.0632
95% BCA Bootstrap UCL	0.0651	95% Bootstrap t UCL	0.0733
95% H-UCL (Log ROS)	0.0736		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.59	KM Geo Mean	0.0751
KM SD (logged)	0.178	95% Critical H Value (KM-Log)	1.803
KM Standard Error of Mean (logged)	0.0672	95% H-UCL (KM -Log)	0.0833
KM SD (logged)	0.178	95% Critical H Value (KM-Log)	1.803
KM Standard Error of Mean (logged)	0.0672		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0464	Mean in Log Scale	-3.184
SD in Original Scale	0.0296	SD in Log Scale	0.432
95% t UCL (Assumes normality)	0.0605	95% H-Stat UCL	0.0578

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0876	KM H-UCL	0.0833
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Selenium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	5
Number of Detects	1	Number of Non-Detects	13
Number of Distinct Detects	1	Number of Distinct Non-Detects	4

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Selenium (mg/kg) was not processed!

Silver (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	5
Number of Detects	4	Number of Non-Detects	10
Number of Distinct Detects	4	Number of Distinct Non-Detects	1

Minimum Detect	0.14	Minimum Non-Detect	0.15
Maximum Detect	0.35	Maximum Non-Detect	0.15
Variance Detects	0.00996	Percent Non-Detects	71.43%
Mean Detects	0.233	SD Detects	0.0998
Median Detects	0.22	CV Detects	0.429
Skewness Detects	0.374	Kurtosis Detects	-3.532
Mean of Logged Detects	-1.53	SD of Logged Detects	0.439

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.266	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.166	KM Standard Error of Mean	0.0192
KM SD	0.0623	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.2	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.198	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.224	95% KM Chebyshev UCL	0.25
97.5% KM Chebyshev UCL	0.286	99% KM Chebyshev UCL	0.358

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.368	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.292	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.155	k star (bias corrected MLE)	1.955
Theta hat (MLE)	0.0325	Theta star (bias corrected MLE)	0.119
nu hat (MLE)	57.24	nu star (bias corrected)	15.64
Mean (detects)	0.233		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0298	Mean	0.147
Maximum	0.35	Median	0.139
SD	0.0855	CV	0.581
k hat (MLE)	3.133	k star (bias corrected MLE)	2.509
Theta hat (MLE)	0.047	Theta star (bias corrected MLE)	0.0587
nu hat (MLE)	87.71	nu star (bias corrected)	70.25
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (70.25, α)	51.95	Adjusted Chi Square Value (70.25, β)	49.87
95% Gamma Approximate UCL (use when n>=50)	0.199	95% Gamma Adjusted UCL (use when n<50)	N/A

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.166	SD (KM)	0.0623
Variance (KM)	0.00388	SE of Mean (KM)	0.0192
k hat (KM)	7.139	k star (KM)	5.657
nu hat (KM)	199.9	nu star (KM)	158.4
theta hat (KM)	0.0233	theta star (KM)	0.0294
80% gamma percentile (KM)	0.221	90% gamma percentile (KM)	0.26
95% gamma percentile (KM)	0.296	99% gamma percentile (KM)	0.371

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (158.38, α)	130.3	Adjusted Chi Square Value (158.38, β)	126.9
95% Gamma Approximate KM-UCL (use when n>=50)	0.202	95% Gamma Adjusted KM-UCL (use when n<50)	0.208

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.158	Mean in Log Scale	-1.929
SD in Original Scale	0.0747	SD in Log Scale	0.416
95% t UCL (assumes normality of ROS data)	0.194	95% Percentile Bootstrap UCL	0.191
95% BCA Bootstrap UCL	0.198	95% Bootstrap t UCL	0.22
95% H-UCL (Log ROS)	0.199		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.842	KM Geo Mean	0.159
KM SD (logged)	0.283	95% Critical H Value (KM-Log)	1.88
KM Standard Error of Mean (logged)	0.0873	95% H-UCL (KM -Log)	0.191
KM SD (logged)	0.283	95% Critical H Value (KM-Log)	1.88
KM Standard Error of Mean (logged)	0.0873		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.12	Mean in Log Scale	-2.287
SD in Original Scale	0.088	SD in Log Scale	0.54
95% t UCL (Assumes normality)	0.162	95% H-Stat UCL	0.16

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Thallium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	12
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.5	Minimum Non-Detect	0.3
Maximum Detect	0.57	Maximum Non-Detect	0.31
Variance Detects	0.00245	Percent Non-Detects	85.71%
Mean Detects	0.535	SD Detects	0.0495
Median Detects	0.535	CV Detects	0.0925
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.628	SD of Logged Detects	0.0927

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.334	KM Standard Error of Mean	0.0315
KM SD	0.0833	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.389	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.385	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.428	95% KM Chebyshev UCL	0.471
97.5% KM Chebyshev UCL	0.53	99% KM Chebyshev UCL	0.647

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	233.3	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00229	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	933.3	nu star (bias corrected)	N/A
Mean (detects)	0.535		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.334	SD (KM)	0.0833
Variance (KM)	0.00694	SE of Mean (KM)	0.0315
k hat (KM)	16.04	k star (KM)	12.65
nu hat (KM)	449.1	nu star (KM)	354.2
theta hat (KM)	0.0208	theta star (KM)	0.0264
80% gamma percentile (KM)	0.409	90% gamma percentile (KM)	0.458
95% gamma percentile (KM)	0.501	99% gamma percentile (KM)	0.59

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0312
Approximate Chi Square Value (354.20, α)	311.6	Adjusted Chi Square Value (354.20, β)	306.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.379	95% Gamma Adjusted KM-UCL (use when n<50)	0.386

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.328	Mean in Log Scale	-1.164
SD in Original Scale	0.109	SD in Log Scale	0.321
95% t UCL (assumes normality of ROS data)	0.38	95% Percentile Bootstrap UCL	0.375
95% BCA Bootstrap UCL	0.383	95% Bootstrap t UCL	0.395
95% H-UCL (Log ROS)	0.39		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.122	KM Geo Mean	0.326
KM SD (logged)	0.203	95% Critical H Value (KM-Log)	1.82
KM Standard Error of Mean (logged)	0.0768	95% H-UCL (KM -Log)	0.368
KM SD (logged)	0.203	95% Critical H Value (KM-Log)	1.82
KM Standard Error of Mean (logged)	0.0768		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.209	Mean in Log Scale	-1.69
SD in Original Scale	0.139	SD in Log Scale	0.451
95% t UCL (Assumes normality)	0.275	95% H-Stat UCL	0.262

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.389	KM H-UCL	0.368
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	13
		Number of Missing Observations	0
Minimum	7.4	Mean	20.13
Maximum	41.5	Median	17.65
SD	11.02	Std. Error of Mean	2.945
Coefficient of Variation	0.547	Skewness	1.094

Normal GOF Test

Shapiro Wilk Test Statistic	0.852	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.269	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	25.35	95% Adjusted-CLT UCL (Chen-1995)	25.9
		95% Modified-t UCL (Johnson-1978)	25.49

Gamma GOF Test

A-D Test Statistic	0.456	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.201	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.23	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.024	k star (bias corrected MLE)	3.21
Theta hat (MLE)	5.003	Theta star (bias corrected MLE)	6.273
nu hat (MLE)	112.7	nu star (bias corrected)	89.87
MLE Mean (bias corrected)	20.13	MLE Sd (bias corrected)	11.24
		Approximate Chi Square Value (0.05)	69.01
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	66.59

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	26.22	95% Adjusted Gamma UCL (use when n<50)	27.17

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.172	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.001	Mean of logged Data	2.873
Maximum of Logged Data	3.726	SD of logged Data	0.525

Assuming Lognormal Distribution

95% H-UCL	27.33	90% Chebyshev (MVUE) UCL	28.8
95% Chebyshev (MVUE) UCL	32.75	97.5% Chebyshev (MVUE) UCL	38.23
99% Chebyshev (MVUE) UCL	48.99		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	24.98	95% Jackknife UCL	25.35
95% Standard Bootstrap UCL	24.68	95% Bootstrap-t UCL	28.32
95% Hall's Bootstrap UCL	26.5	95% Percentile Bootstrap UCL	25.35
95% BCA Bootstrap UCL	25.58		
90% Chebyshev(Mean, Sd) UCL	28.97	95% Chebyshev(Mean, Sd) UCL	32.97
97.5% Chebyshev(Mean, Sd) UCL	38.52	99% Chebyshev(Mean, Sd) UCL	49.43

Appendix D, Table 24. ProUCL Output - Amphibian/Aquatic Reptile Tissue (Frog Legs)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Adjusted Gamma UCL 27.17

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 3:51:49 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	19
Number of Detects	17	Number of Non-Detects	2
Number of Distinct Detects	17	Number of Distinct Non-Detects	2
Minimum Detect	0.64	Minimum Non-Detect	0.62
Maximum Detect	14	Maximum Non-Detect	0.63
Variance Detects	9.521	Percent Non-Detects	10.53%
Mean Detects	3.095	SD Detects	3.086
Median Detects	2.32	CV Detects	0.997
Skewness Detects	3.016	Kurtosis Detects	10.67
Mean of Logged Detects	0.834	SD of Logged Detects	0.754

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.65	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.835	KM Standard Error of Mean	0.693
KM SD	2.932	95% KM (BCA) UCL	4.026
95% KM (t) UCL	4.037	95% KM (Percentile Bootstrap) UCL	4.099
95% KM (z) UCL	3.975	95% KM Bootstrap t UCL	5.086
90% KM Chebyshev UCL	4.915	95% KM Chebyshev UCL	5.857
97.5% KM Chebyshev UCL	7.164	99% KM Chebyshev UCL	9.733

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.5	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.751	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.139	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.212	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.837	k star (bias corrected MLE)	1.552
Theta hat (MLE)	1.685	Theta star (bias corrected MLE)	1.995
nu hat (MLE)	62.45	nu star (bias corrected)	52.76
Mean (detects)	3.095		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.771
Maximum	14	Median	1.77
SD	3.067	CV	1.107
k hat (MLE)	0.785	k star (bias corrected MLE)	0.696
Theta hat (MLE)	3.529	Theta star (bias corrected MLE)	3.98
nu hat (MLE)	29.83	nu star (bias corrected)	26.45
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (26.45, α)	15.73	Adjusted Chi Square Value (26.45, β)	15.01
95% Gamma Approximate UCL (use when n>=50)	4.66	95% Gamma Adjusted UCL (use when n<50)	4.884

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.835	SD (KM)	2.932
Variance (KM)	8.595	SE of Mean (KM)	0.693
k hat (KM)	0.935	k star (KM)	0.822
nu hat (KM)	35.53	nu star (KM)	31.25
theta hat (KM)	3.032	theta star (KM)	3.447
80% gamma percentile (KM)	4.625	90% gamma percentile (KM)	6.847
95% gamma percentile (KM)	9.105	99% gamma percentile (KM)	14.43

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (31.25, α)	19.48	Adjusted Chi Square Value (31.25, β)	18.67
95% Gamma Approximate KM-UCL (use when n>=50)	4.548	95% Gamma Adjusted KM-UCL (use when n<50)	4.745

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.112	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.812	Mean in Log Scale	0.65
SD in Original Scale	3.031	SD in Log Scale	0.9
95% t UCL (assumes normality of ROS data)	4.017	95% Percentile Bootstrap UCL	4.017
95% BCA Bootstrap UCL	4.635	95% Bootstrap t UCL	5.119
95% H-UCL (Log ROS)	4.848		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.696	KM Geo Mean	2.005
KM SD (logged)	0.801	95% Critical H Value (KM-Log)	2.343
KM Standard Error of Mean (logged)	0.189	95% H-UCL (KM -Log)	4.299
KM SD (logged)	0.801	95% Critical H Value (KM-Log)	2.343
KM Standard Error of Mean (logged)	0.189		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.802	Mean in Log Scale	0.623
SD in Original Scale	3.039	SD in Log Scale	0.95
95% t UCL (Assumes normality)	4.011	95% H-Stat UCL	5.172

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	4.745	95% GROS Adjusted Gamma UCL	4.884

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	18
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Antimony (mg/kg) was not processed!

Arsenic (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	18
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Arsenic (mg/kg) was not processed!

Barium (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	10
Number of Detects	12	Number of Non-Detects	7
Number of Distinct Detects	6	Number of Distinct Non-Detects	4

Minimum Detect	0.03	Minimum Non-Detect	0.01
Maximum Detect	0.24	Maximum Non-Detect	0.2
Variance Detects	0.00344	Percent Non-Detects	36.84%
Mean Detects	0.0658	SD Detects	0.0587
Median Detects	0.05	CV Detects	0.892
Skewness Detects	2.772	Kurtosis Detects	8.285
Mean of Logged Detects	-2.933	SD of Logged Detects	0.603

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.614	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.356	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.243	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0559	KM Standard Error of Mean	0.012
KM SD	0.0484	95% KM (BCA) UCL	0.0776
95% KM (t) UCL	0.0768	95% KM (Percentile Bootstrap) UCL	0.0767
95% KM (z) UCL	0.0757	95% KM Bootstrap t UCL	0.0999
90% KM Chebyshev UCL	0.092	95% KM Chebyshev UCL	0.108
97.5% KM Chebyshev UCL	0.131	99% KM Chebyshev UCL	0.176

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.107	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.74	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.329	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.248	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.509	k star (bias corrected MLE)	1.937
Theta hat (MLE)	0.0262	Theta star (bias corrected MLE)	0.034
nu hat (MLE)	60.21	nu star (bias corrected)	46.49
Mean (detects)	0.0658		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0555
Maximum	0.24	Median	0.04
SD	0.0502	CV	0.905
k hat (MLE)	2.108	k star (bias corrected MLE)	1.81
Theta hat (MLE)	0.0263	Theta star (bias corrected MLE)	0.0307
nu hat (MLE)	80.09	nu star (bias corrected)	68.78
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (68.78, α)	50.69	Adjusted Chi Square Value (68.78, β)	49.33
95% Gamma Approximate UCL (use when n>=50)	0.0753	95% Gamma Adjusted UCL (use when n<50)	0.0774

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0559	SD (KM)	0.0484
Variance (KM)	0.00234	SE of Mean (KM)	0.012
k hat (KM)	1.334	k star (KM)	1.159
nu hat (KM)	50.71	nu star (KM)	44.04
theta hat (KM)	0.0419	theta star (KM)	0.0482
80% gamma percentile (KM)	0.0888	90% gamma percentile (KM)	0.124
95% gamma percentile (KM)	0.159	99% gamma percentile (KM)	0.239

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (44.04, α)	29.82	Adjusted Chi Square Value (44.04, β)	28.79
95% Gamma Approximate KM-UCL (use when n>=50)	0.0826	95% Gamma Adjusted KM-UCL (use when n<50)	0.0855

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.833	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.859	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.291	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.243	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0564	Mean in Log Scale	-3.073
SD in Original Scale	0.0488	SD in Log Scale	0.585
95% t UCL (assumes normality of ROS data)	0.0758	95% Percentile Bootstrap UCL	0.0761
95% BCA Bootstrap UCL	0.0842	95% Bootstrap t UCL	0.103
95% H-UCL (Log ROS)	0.0733		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.121	KM Geo Mean	0.0441
KM SD (logged)	0.665	95% Critical H Value (KM-Log)	2.181
KM Standard Error of Mean (logged)	0.181	95% H-UCL (KM -Log)	0.0775
KM SD (logged)	0.665	95% Critical H Value (KM-Log)	2.181
KM Standard Error of Mean (logged)	0.181		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0671	Mean in Log Scale	-2.956
SD in Original Scale	0.0514	SD in Log Scale	0.795
95% t UCL (Assumes normality)	0.0876	95% H-Stat UCL	0.111

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.108

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Beryllium (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	18
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Beryllium (mg/kg) was not processed!

Cadmium (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	5
Number of Detects	8	Number of Non-Detects	11
Number of Distinct Detects	5	Number of Distinct Non-Detects	1
Minimum Detect	0.03	Minimum Non-Detect	0.03
Maximum Detect	0.09	Maximum Non-Detect	0.03
Variance Detects	4.7857E-4	Percent Non-Detects	57.89%
Mean Detects	0.0525	SD Detects	0.0219
Median Detects	0.04	CV Detects	0.417
Skewness Detects	0.996	Kurtosis Detects	-0.549
Mean of Logged Detects	-3.016	SD of Logged Detects	0.388

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.821	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.341	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0395	KM Standard Error of Mean	0.00425
KM SD	0.0173	95% KM (BCA) UCL	0.0468
95% KM (t) UCL	0.0468	95% KM (Percentile Bootstrap) UCL	0.0468
95% KM (z) UCL	0.0465	95% KM Bootstrap t UCL	0.0538
90% KM Chebyshev UCL	0.0522	95% KM Chebyshev UCL	0.058
97.5% KM Chebyshev UCL	0.066	99% KM Chebyshev UCL	0.0817

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.726	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.717	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.345	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.295	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.388	k star (bias corrected MLE)	4.701
Theta hat (MLE)	0.00711	Theta star (bias corrected MLE)	0.0112
nu hat (MLE)	118.2	nu star (bias corrected)	75.21
Mean (detects)	0.0525		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0286
Maximum	0.09	Median	0.0146
SD	0.0251	CV	0.875
k hat (MLE)	1.676	k star (bias corrected MLE)	1.446
Theta hat (MLE)	0.0171	Theta star (bias corrected MLE)	0.0198
nu hat (MLE)	63.69	nu star (bias corrected)	54.96
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (54.96, α)	38.93	Adjusted Chi Square Value (54.96, β)	37.75
95% Gamma Approximate UCL (use when n>=50)	0.0404	95% Gamma Adjusted UCL (use when n<50)	0.0417

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0395	SD (KM)	0.0173
Variance (KM)	2.9972E-4	SE of Mean (KM)	0.00425
k hat (KM)	5.199	k star (KM)	4.413
nu hat (KM)	197.6	nu star (KM)	167.7
theta hat (KM)	0.00759	theta star (KM)	0.00894
80% gamma percentile (KM)	0.0538	90% gamma percentile (KM)	0.0646
95% gamma percentile (KM)	0.0746	99% gamma percentile (KM)	0.0957

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (167.69, α)	138.7	Adjusted Chi Square Value (167.69, β)	136.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.0477	95% Gamma Adjusted KM-UCL (use when n<50)	0.0485

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.863	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.324	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0312	Mean in Log Scale	-3.722
SD in Original Scale	0.0236	SD in Log Scale	0.741
95% t UCL (assumes normality of ROS data)	0.0406	95% Percentile Bootstrap UCL	0.04
95% BCA Bootstrap UCL	0.0419	95% Bootstrap t UCL	0.0443
95% H-UCL (Log ROS)	0.0473		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.3	KM Geo Mean	0.0369
KM SD (logged)	0.338	95% Critical H Value (KM-Log)	1.872
KM Standard Error of Mean (logged)	0.0829	95% H-UCL (KM -Log)	0.0453
KM SD (logged)	0.338	95% Critical H Value (KM-Log)	1.872
KM Standard Error of Mean (logged)	0.0829		

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0308	Mean in Log Scale	-3.701
SD in Original Scale	0.0234	SD in Log Scale	0.647
95% t UCL (Assumes normality)	0.0401	95% H-Stat UCL	0.0423

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0468

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	9
Number of Detects	9	Number of Non-Detects	10
Number of Distinct Detects	6	Number of Distinct Non-Detects	3
Minimum Detect	0.08	Minimum Non-Detect	0.06
Maximum Detect	0.88	Maximum Non-Detect	0.24
Variance Detects	0.0673	Percent Non-Detects	52.63%
Mean Detects	0.192	SD Detects	0.259
Median Detects	0.09	CV Detects	1.35
Skewness Detects	2.934	Kurtosis Detects	8.693
Mean of Logged Detects	-2.034	SD of Logged Detects	0.753

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.477	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.423	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.125	KM Standard Error of Mean	0.044
KM SD	0.18	95% KM (BCA) UCL	0.211
95% KM (t) UCL	0.201	95% KM (Percentile Bootstrap) UCL	0.207
95% KM (z) UCL	0.197	95% KM Bootstrap t UCL	0.545
90% KM Chebyshev UCL	0.257	95% KM Chebyshev UCL	0.317
97.5% KM Chebyshev UCL	0.4	99% KM Chebyshev UCL	0.563

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.798	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.735	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.339	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.284	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.444	k star (bias corrected MLE)	1.036
Theta hat (MLE)	0.133	Theta star (bias corrected MLE)	0.185
nu hat (MLE)	25.98	nu star (bias corrected)	18.66
Mean (detects)	0.192		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0963
Maximum	0.88	Median	0.01
SD	0.197	CV	2.041
k hat (MLE)	0.591	k star (bias corrected MLE)	0.533
Theta hat (MLE)	0.163	Theta star (bias corrected MLE)	0.181
nu hat (MLE)	22.47	nu star (bias corrected)	20.26
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (20.26, α)	11.04	Adjusted Chi Square Value (20.26, β)	10.45
95% Gamma Approximate UCL (use when n>=50)	0.177	95% Gamma Adjusted UCL (use when n<50)	0.187

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.125	SD (KM)	0.18
Variance (KM)	0.0325	SE of Mean (KM)	0.044
k hat (KM)	0.481	k star (KM)	0.44
nu hat (KM)	18.26	nu star (KM)	16.71
theta hat (KM)	0.26	theta star (KM)	0.284
80% gamma percentile (KM)	0.204	90% gamma percentile (KM)	0.347
95% gamma percentile (KM)	0.503	99% gamma percentile (KM)	0.89

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (16.71, α)	8.467	Adjusted Chi Square Value (16.71, β)	7.957
95% Gamma Approximate KM-UCL (use when n>=50)	0.247	95% Gamma Adjusted KM-UCL (use when n<50)	0.263

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.645	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.281	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.107	Mean in Log Scale	-2.89
SD in Original Scale	0.192	SD in Log Scale	1.066
95% t UCL (assumes normality of ROS data)	0.183	95% Percentile Bootstrap UCL	0.191
95% BCA Bootstrap UCL	0.24	95% Bootstrap t UCL	0.384
95% H-UCL (Log ROS)	0.193		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.416	KM Geo Mean	0.0893
KM SD (logged)	0.622	95% Critical H Value (KM-Log)	2.133
KM Standard Error of Mean (logged)	0.154	95% H-UCL (KM -Log)	0.148
KM SD (logged)	0.622	95% Critical H Value (KM-Log)	2.133
KM Standard Error of Mean (logged)	0.154		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.115	Mean in Log Scale	-2.673
SD in Original Scale	0.19	SD in Log Scale	0.889
95% t UCL (Assumes normality)	0.191	95% H-Stat UCL	0.171

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.317

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	19
Number of Detects	14	Number of Non-Detects	5
Number of Distinct Detects	14	Number of Distinct Non-Detects	5
Minimum Detect	0.43	Minimum Non-Detect	0.74
Maximum Detect	2.17	Maximum Non-Detect	1.31
Variance Detects	0.295	Percent Non-Detects	26.32%
Mean Detects	1.435	SD Detects	0.543
Median Detects	1.595	CV Detects	0.379
Skewness Detects	-0.674	Kurtosis Detects	-0.604
Mean of Logged Detects	0.267	SD of Logged Detects	0.497

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.17	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.203	KM Standard Error of Mean	0.145
KM SD	0.6	95% KM (BCA) UCL	1.454
95% KM (t) UCL	1.455	95% KM (Percentile Bootstrap) UCL	1.446
95% KM (z) UCL	1.442	95% KM Bootstrap t UCL	1.443
90% KM Chebyshev UCL	1.638	95% KM Chebyshev UCL	1.835
97.5% KM Chebyshev UCL	2.108	99% KM Chebyshev UCL	2.645

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.744	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.738	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.21	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.229	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.443	k star (bias corrected MLE)	4.325
Theta hat (MLE)	0.264	Theta star (bias corrected MLE)	0.332
nu hat (MLE)	152.4	nu star (bias corrected)	121.1
Mean (detects)	1.435		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.43	Mean	1.249
Maximum	2.17	Median	1.29
SD	0.563	CV	0.451
k hat (MLE)	4.691	k star (bias corrected MLE)	3.986
Theta hat (MLE)	0.266	Theta star (bias corrected MLE)	0.313
nu hat (MLE)	178.3	nu star (bias corrected)	151.5
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (151.46, α)	124	Adjusted Chi Square Value (151.46, β)	121.8
95% Gamma Approximate UCL (use when n>=50)	1.525	95% Gamma Adjusted UCL (use when n<50)	1.552

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.203	SD (KM)	0.6
Variance (KM)	0.361	SE of Mean (KM)	0.145
k hat (KM)	4.016	k star (KM)	3.417
nu hat (KM)	152.6	nu star (KM)	129.9
theta hat (KM)	0.3	theta star (KM)	0.352
80% gamma percentile (KM)	1.69	90% gamma percentile (KM)	2.076
95% gamma percentile (KM)	2.434	99% gamma percentile (KM)	3.205

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (129.86, α)	104.5	Adjusted Chi Square Value (129.86, β)	102.5
95% Gamma Approximate KM-UCL (use when n>=50)	1.495	95% Gamma Adjusted KM-UCL (use when n<50)	1.524

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.842	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.216	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.23	Mean in Log Scale	0.0842
SD in Original Scale	0.582	SD in Log Scale	0.527
95% t UCL (assumes normality of ROS data)	1.461	95% Percentile Bootstrap UCL	1.44
95% BCA Bootstrap UCL	1.426	95% Bootstrap t UCL	1.451
95% H-UCL (Log ROS)	1.61		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.0313	KM Geo Mean	1.032
KM SD (logged)	0.584	95% Critical H Value (KM-Log)	2.093
KM Standard Error of Mean (logged)	0.144	95% H-UCL (KM -Log)	1.633
KM SD (logged)	0.584	95% Critical H Value (KM-Log)	2.093
KM Standard Error of Mean (logged)	0.144		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.178	Mean in Log Scale	-0.0156
SD in Original Scale	0.642	SD in Log Scale	0.652
95% t UCL (Assumes normality)	1.433	95% H-Stat UCL	1.699

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.455

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	10.2	Mean	32.73
Maximum	65.9	Median	34.1
SD	13.89	Std. Error of Mean	3.187
Coefficient of Variation	0.424	Skewness	0.463

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.128	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	38.25	95% Adjusted-CLT UCL (Chen-1995)	38.33
		95% Modified-t UCL (Johnson-1978)	38.31

Gamma GOF Test

A-D Test Statistic	0.344	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.186	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.199	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.308	k star (bias corrected MLE)	4.505
Theta hat (MLE)	6.166	Theta star (bias corrected MLE)	7.265
nu hat (MLE)	201.7	nu star (bias corrected)	171.2
MLE Mean (bias corrected)	32.73	MLE Sd (bias corrected)	15.42
		Approximate Chi Square Value (0.05)	141.9
Adjusted Level of Significance	0.0369	Adjusted Chi Square Value	139.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	39.47	95% Adjusted Gamma UCL (use when n<50)	40.13

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.901	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.197	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.322	Mean of logged Data	3.391
Maximum of Logged Data	4.188	SD of logged Data	0.476

Assuming Lognormal Distribution

95% H-UCL	41.58	90% Chebyshev (MVUE) UCL	44.24
95% Chebyshev (MVUE) UCL	49.3	97.5% Chebyshev (MVUE) UCL	56.34
99% Chebyshev (MVUE) UCL	70.16		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	37.97	95% Jackknife UCL	38.25
95% Standard Bootstrap UCL	37.9	95% Bootstrap-t UCL	38.58
95% Hall's Bootstrap UCL	38.68	95% Percentile Bootstrap UCL	37.89
95% BCA Bootstrap UCL	38.21		
90% Chebyshev(Mean, Sd) UCL	42.29	95% Chebyshev(Mean, Sd) UCL	46.62
97.5% Chebyshev(Mean, Sd) UCL	52.63	99% Chebyshev(Mean, Sd) UCL	64.44

Suggested UCL to Use

95% Student's-t UCL 38.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	17
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	2.58	Minimum Non-Detect	0.23
Maximum Detect	5.17	Maximum Non-Detect	0.24
Variance Detects	3.354	Percent Non-Detects	89.47%
Mean Detects	3.875	SD Detects	1.831
Median Detects	3.875	CV Detects	0.473
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	1.295	SD of Logged Detects	0.491

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only

Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.614	KM Standard Error of Mean	0.388
KM SD	1.195	95% KM (BCA) UCL	N/A
95% KM (t) UCL	1.286	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	1.251	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	1.777	95% KM Chebyshev UCL	2.304
97.5% KM Chebyshev UCL	3.035	99% KM Chebyshev UCL	4.471

Gamma GOF Tests on Detected Observations Only

Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	8.607	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.45	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	34.43	nu star (bias corrected)	N/A
Mean (detects)	3.875		

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.614	SD (KM)	1.195
Variance (KM)	1.428	SE of Mean (KM)	0.388
k hat (KM)	0.264	k star (KM)	0.257
nu hat (KM)	10.02	nu star (KM)	9.774
theta hat (KM)	2.327	theta star (KM)	2.386
80% gamma percentile (KM)	0.9	90% gamma percentile (KM)	1.838
95% gamma percentile (KM)	2.945	99% gamma percentile (KM)	5.881

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0369
Approximate Chi Square Value (9.77, α)	3.801	Adjusted Chi Square Value (9.77, β)	3.481
95% Gamma Approximate KM-UCL (use when n>=50)	1.578	95% Gamma Adjusted KM-UCL (use when n<50)	1.723

Lognormal GOF Test on Detected Observations Only

Not Enough Data to Perform GOF Test

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.58	Mean in Log Scale	-2.059
SD in Original Scale	1.259	SD in Log Scale	1.808
95% t UCL (assumes normality of ROS data)	1.081	95% Percentile Bootstrap UCL	1.104
95% BCA Bootstrap UCL	1.323	95% Bootstrap t UCL	2.99
95% H-UCL (Log ROS)	3.47		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.179	KM Geo Mean	0.308
KM SD (logged)	0.856	95% Critical H Value (KM-Log)	2.414
KM Standard Error of Mean (logged)	0.278	95% H-UCL (KM -Log)	0.722
KM SD (logged)	0.856	95% Critical H Value (KM-Log)	2.414
KM Standard Error of Mean (logged)	0.278		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.514	Mean in Log Scale	-1.77
SD in Original Scale	1.261	SD in Log Scale	1.086
95% t UCL (Assumes normality)	1.016	95% H-Stat UCL	0.619

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	1.286	KM H-UCL	0.722
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Manganese (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	15
Number of Detects	15	Number of Non-Detects	4
Number of Distinct Detects	11	Number of Distinct Non-Detects	4
Minimum Detect	0.11	Minimum Non-Detect	0.1
Maximum Detect	1.37	Maximum Non-Detect	0.23
Variance Detects	0.0926	Percent Non-Detects	21.05%
Mean Detects	0.307	SD Detects	0.304
Median Detects	0.24	CV Detects	0.99
Skewness Detects	3.445	Kurtosis Detects	12.62
Mean of Logged Detects	-1.4	SD of Logged Detects	0.589

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.523	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.363	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.267	KM Standard Error of Mean	0.0648
KM SD	0.273	95% KM (BCA) UCL	0.397
95% KM (t) UCL	0.38	95% KM (Percentile Bootstrap) UCL	0.387
95% KM (z) UCL	0.374	95% KM Bootstrap t UCL	0.577
90% KM Chebyshev UCL	0.462	95% KM Chebyshev UCL	0.55
97.5% KM Chebyshev UCL	0.672	99% KM Chebyshev UCL	0.912

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.37	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.276	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.224	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.424	k star (bias corrected MLE)	1.983
Theta hat (MLE)	0.127	Theta star (bias corrected MLE)	0.155
nu hat (MLE)	72.71	nu star (bias corrected)	59.5
Mean (detects)	0.307		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.248
Maximum	1.37	Median	0.19
SD	0.294	CV	1.186
k hat (MLE)	0.994	k star (bias corrected MLE)	0.872
Theta hat (MLE)	0.249	Theta star (bias corrected MLE)	0.284
nu hat (MLE)	37.78	nu star (bias corrected)	33.15
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (33.15, α)	20.99	Adjusted Chi Square Value (33.15, β)	20.14
95% Gamma Approximate UCL (use when n>=50)	0.391	95% Gamma Adjusted UCL (use when n<50)	0.408

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.267	SD (KM)	0.273
Variance (KM)	0.0744	SE of Mean (KM)	0.0648
k hat (KM)	0.961	k star (KM)	0.844
nu hat (KM)	36.52	nu star (KM)	32.09
theta hat (KM)	0.278	theta star (KM)	0.317
80% gamma percentile (KM)	0.436	90% gamma percentile (KM)	0.642
95% gamma percentile (KM)	0.851	99% gamma percentile (KM)	1.342

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (32.09, α)	20.14	Adjusted Chi Square Value (32.09, β)	19.32
95% Gamma Approximate KM-UCL (use when n>=50)	0.426	95% Gamma Adjusted KM-UCL (use when n<50)	0.444

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.848	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.216	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.263	Mean in Log Scale	-1.603
SD in Original Scale	0.283	SD in Log Scale	0.671
95% t UCL (assumes normality of ROS data)	0.376	95% Percentile Bootstrap UCL	0.38
95% BCA Bootstrap UCL	0.459	95% Bootstrap t UCL	0.554
95% H-UCL (Log ROS)	0.356		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.561	KM Geo Mean	0.21
KM SD (logged)	0.602	95% Critical H Value (KM-Log)	2.112
KM Standard Error of Mean (logged)	0.144	95% H-UCL (KM -Log)	0.339
KM SD (logged)	0.602	95% Critical H Value (KM-Log)	2.112
KM Standard Error of Mean (logged)	0.144		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.259	Mean in Log Scale	-1.65
SD in Original Scale	0.285	SD in Log Scale	0.733
95% t UCL (Assumes normality)	0.373	95% H-Stat UCL	0.371

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 0.339

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Mercury (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	8.6000E-4	Mean	0.0435
Maximum	0.137	Median	0.0357
SD	0.0361	Std. Error of Mean	0.00829
Coefficient of Variation	0.83	Skewness	1.067

Normal GOF Test

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0579	95% Adjusted-CLT UCL (Chen-1995)	0.0593
		95% Modified-t UCL (Johnson-1978)	0.0582

Gamma GOF Test

A-D Test Statistic	0.531	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.77	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.179	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.204	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.984	k star (bias corrected MLE)	0.864
Theta hat (MLE)	0.0442	Theta star (bias corrected MLE)	0.0504
nu hat (MLE)	37.4	nu star (bias corrected)	32.83
MLE Mean (bias corrected)	0.0435	MLE Sd (bias corrected)	0.0468
		Approximate Chi Square Value (0.05)	20.73
Adjusted Level of Significance	0.0369	Adjusted Chi Square Value	19.89

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0689	95% Adjusted Gamma UCL (use when n<50)	0.0718

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.84	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.901	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.239	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.197	Data Not Lognormal at 5% Significance Level

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-7.059	Mean of logged Data	-3.723
Maximum of Logged Data	-1.988	SD of logged Data	1.451

Assuming Lognormal Distribution

95% H-UCL	0.214	90% Chebyshev (MVUE) UCL	0.137
95% Chebyshev (MVUE) UCL	0.17	97.5% Chebyshev (MVUE) UCL	0.216
99% Chebyshev (MVUE) UCL	0.308		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.0571	95% Jackknife UCL	0.0579
95% Standard Bootstrap UCL	0.0568	95% Bootstrap-t UCL	0.061
95% Hall's Bootstrap UCL	0.0627	95% Percentile Bootstrap UCL	0.0574
95% BCA Bootstrap UCL	0.0587		
90% Chebyshev(Mean, Sd) UCL	0.0684	95% Chebyshev(Mean, Sd) UCL	0.0796
97.5% Chebyshev(Mean, Sd) UCL	0.0952	99% Chebyshev(Mean, Sd) UCL	0.126

Suggested UCL to Use

95% Student's-t UCL 0.0579

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	18
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV)

The data set for variable Nickel (mg/kg) was not processed!

Selenium (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	8
Number of Detects	5	Number of Non-Detects	14
Number of Distinct Detects	5	Number of Distinct Non-Detects	3

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum Detect	0.78	Minimum Non-Detect	0.72
Maximum Detect	0.93	Maximum Non-Detect	0.74
Variance Detects	0.00497	Percent Non-Detects	73.68%
Mean Detects	0.852	SD Detects	0.0705
Median Detects	0.84	CV Detects	0.0827
Skewness Detects	0.209	Kurtosis Detects	-2.936
Mean of Logged Detects	-0.163	SD of Logged Detects	0.0825

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.864	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.755	KM Standard Error of Mean	0.0171
KM SD	0.0665	95% KM (BCA) UCL	0.784
95% KM (t) UCL	0.784	95% KM (Percentile Bootstrap) UCL	0.783
95% KM (z) UCL	0.783	95% KM Bootstrap t UCL	0.773
90% KM Chebyshev UCL	0.806	95% KM Chebyshev UCL	0.829
97.5% KM Chebyshev UCL	0.861	99% KM Chebyshev UCL	0.925

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.44	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.678	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.259	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.357	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	183.4	k star (bias corrected MLE)	73.48
Theta hat (MLE)	0.00465	Theta star (bias corrected MLE)	0.0116
nu hat (MLE)	1834	nu star (bias corrected)	734.8
Mean (detects)	0.852		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.395	Mean	0.65
Maximum	0.93	Median	0.63
SD	0.151	CV	0.232
k hat (MLE)	19.7	k star (bias corrected MLE)	16.62
Theta hat (MLE)	0.033	Theta star (bias corrected MLE)	0.0391
nu hat (MLE)	748.5	nu star (bias corrected)	631.7
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (631.68, α)	574.4	Adjusted Chi Square Value (631.68, β)	569.6
95% Gamma Approximate UCL (use when n>=50)	0.715	95% Gamma Adjusted UCL (use when n<50)	0.721

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.755	SD (KM)	0.0665
Variance (KM)	0.00442	SE of Mean (KM)	0.0171
k hat (KM)	128.7	k star (KM)	108.4
nu hat (KM)	4892	nu star (KM)	4121
theta hat (KM)	0.00586	theta star (KM)	0.00696
80% gamma percentile (KM)	0.815	90% gamma percentile (KM)	0.849
95% gamma percentile (KM)	0.878	99% gamma percentile (KM)	0.934

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	3973	Adjusted Chi Square Value (N/A, β)	3960
95% Gamma Approximate KM-UCL (use when n>=50)	0.783	95% Gamma Adjusted KM-UCL (use when n<50)	0.785

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.232	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.675	Mean in Log Scale	-0.41
SD in Original Scale	0.129	SD in Log Scale	0.186
95% t UCL (assumes normality of ROS data)	0.726	95% Percentile Bootstrap UCL	0.721
95% BCA Bootstrap UCL	0.73	95% Bootstrap t UCL	0.731
95% H-UCL (Log ROS)	0.73		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.285	KM Geo Mean	0.752
KM SD (logged)	0.0822	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0211	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.0822	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0211		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.493	Mean in Log Scale	-0.787
SD in Original Scale	0.223	SD in Log Scale	0.385
95% t UCL (Assumes normality)	0.581	95% H-Stat UCL	0.583

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.784

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Thallium (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	4
Number of Detects	2	Number of Non-Detects	17
Number of Distinct Detects	2	Number of Distinct Non-Detects	2
Minimum Detect	0.35	Minimum Non-Detect	0.3
Maximum Detect	0.46	Maximum Non-Detect	0.31
Variance Detects	0.00605	Percent Non-Detects	89.47%
Mean Detects	0.405	SD Detects	0.0778
Median Detects	0.405	CV Detects	0.192
Skewness Detects	N/A	Kurtosis Detects	N/A
Mean of Logged Detects	-0.913	SD of Logged Detects	0.193

Warning: Data set has only 2 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Normal GOF Test on Detects Only
Not Enough Data to Perform GOF Test

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.311	KM Standard Error of Mean	0.012
KM SD	0.0368	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.332	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.331	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.347	95% KM Chebyshev UCL	0.363
97.5% KM Chebyshev UCL	0.386	99% KM Chebyshev UCL	0.43

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	53.89	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00752	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	215.6	nu star (bias corrected)	N/A
Mean (detects)	0.405		

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.311	SD (KM)	0.0368
Variance (KM)	0.00136	SE of Mean (KM)	0.012
k hat (KM)	71.31	k star (KM)	60.09
nu hat (KM)	2710	nu star (KM)	2283
theta hat (KM)	0.00436	theta star (KM)	0.00518
80% gamma percentile (KM)	0.344	90% gamma percentile (KM)	0.363
95% gamma percentile (KM)	0.38	99% gamma percentile (KM)	0.412

Gamma Kaplan-Meier (KM) Statistics

		Adjusted Level of Significance (β)	0.0369
Approximate Chi Square Value (N/A, α)	2173	Adjusted Chi Square Value (N/A, β)	2164
95% Gamma Approximate KM-UCL (use when n>=50)	0.327	95% Gamma Adjusted KM-UCL (use when n<50)	0.328

Lognormal GOF Test on Detected Observations Only
Not Enough Data to Perform GOF Test

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.138	Mean in Log Scale	-2.234
SD in Original Scale	0.111	SD in Log Scale	0.721
95% t UCL (assumes normality of ROS data)	0.182	95% Percentile Bootstrap UCL	0.178
95% BCA Bootstrap UCL	0.191	95% Bootstrap t UCL	0.213
95% H-UCL (Log ROS)	0.203		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.173	KM Geo Mean	0.309
KM SD (logged)	0.0996	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0323	95% H-UCL (KM -Log)	N/A
KM SD (logged)	0.0996	95% Critical H Value (KM-Log)	N/A
KM Standard Error of Mean (logged)	0.0323		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.181	Mean in Log Scale	-1.768
SD in Original Scale	0.0811	SD in Log Scale	0.305
95% t UCL (Assumes normality)	0.213	95% H-Stat UCL	0.204

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.332	KM H-UCL	N/A
95% KM (BCA) UCL	N/A		

Warning: One or more Recommended UCL(s) not available!

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	33.4	Mean	43.22
Maximum	61.2	Median	43.6
SD	6.899	Std. Error of Mean	1.583
Coefficient of Variation	0.16	Skewness	1.025

Normal GOF Test

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	45.97	95% Adjusted-CLT UCL (Chen-1995)	46.22
		95% Modified-t UCL (Johnson-1978)	46.03

Gamma GOF Test

A-D Test Statistic	0.366	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.198	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	44.26	k star (bias corrected MLE)	37.31
Theta hat (MLE)	0.976	Theta star (bias corrected MLE)	1.158
nu hat (MLE)	1682	nu star (bias corrected)	1418
MLE Mean (bias corrected)	43.22	MLE Sd (bias corrected)	7.076
		Approximate Chi Square Value (0.05)	1331
Adjusted Level of Significance	0.0369	Adjusted Chi Square Value	1324

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	46.03	95% Adjusted Gamma UCL (use when n<50)	46.28

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.901	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.135	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.197	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.509	Mean of logged Data	3.755
Maximum of Logged Data	4.114	SD of logged Data	0.153

Assuming Lognormal Distribution

95% H-UCL	46.05	90% Chebyshev (MVUE) UCL	47.76
95% Chebyshev (MVUE) UCL	49.83	97.5% Chebyshev (MVUE) UCL	52.69
99% Chebyshev (MVUE) UCL	58.32		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	45.82	95% Jackknife UCL	45.97
95% Standard Bootstrap UCL	45.82	95% Bootstrap-t UCL	46.36
95% Hall's Bootstrap UCL	47.14	95% Percentile Bootstrap UCL	45.75
95% BCA Bootstrap UCL	46.12		
90% Chebyshev(Mean, Sd) UCL	47.97	95% Chebyshev(Mean, Sd) UCL	50.12
97.5% Chebyshev(Mean, Sd) UCL	53.1	99% Chebyshev(Mean, Sd) UCL	58.97

Appendix D, Table 25. ProUCL Output - Aquatic Mammals Tissue (Raccoon)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Student's-t UCL 45.97

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix E
Analysis of Lead Exposure

APPENDIX E

Analysis of Lead Exposure

E.1 Introduction

This appendix presents the approach, assumptions, and results of the assessment of lead exposure in the human health risk assessment (HHRA) for Tar Creek Superfund Site Operable Unit 5 (OU5). The approach was discussed with the U.S. Environmental Protection Agency (EPA) on August 29, 2019. EPA's Technical Review Workgroup Lead Committee was consulted regarding the approach for lead evaluation for the OU5 study area. The TRW review comments and responses provided on December 17, 2019 (EPA, 2019), are presented in Attachment A of this appendix.

The purpose of the lead analysis is to identify potential unacceptable risk associated with exposure to lead in environmental media within the OU5 study area. Given the elevated concentrations of lead in OU5 study area media that are already known, a conscious effort was made to evaluate potential lead exposures efficiently and effectively without expending considerable effort in identifying specific exposure parameter values characterizing unique OU5 study area exposure scenarios. This approach results in identifying exposure media associated with the potential for elevated blood lead levels (BLLs).

E.2 Approach for Evaluation of Lead Exposure

E.2.1 Integrated Exposure Uptake Biokinetic Model

The potential risks associated with child exposures to lead (tribal lifeway and general public) were evaluated using the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children, Windows, Version 1.1, Build 11 (EPA, 2010). The IEUBK model provides predictions of BLLs for children from ages 0 to 7 years with exposure to lead in various media. This model addresses three components of risk assessments: the multi-media nature of exposures to lead, lead pharmacokinetics, and significant variability in exposure and risk, through estimation of probability distributions of BLLs for children exposed to similar environmental concentrations. The IEUBK model is a probabilistic model designed to predict the cumulative distribution of BLLs based on central tendency exposure (CTE) parameter values. Therefore, the arithmetic mean values of the lead concentrations in sediment[1] and surface water[2] (as shown in Table 1 of this appendix, and as presented in the Risk Assessment Guidance for Superfund [RAGS] Table 3 series in Appendix B of the HHRA) were used as soil and drinking water exposure point concentrations (EPCs), respectively, in the analysis.[3] All the other default input parameter values in the IEUBK model (Table 2) were used for the initial analysis, except for the mother's BLL at childbirth, which was updated to 0.6 micrograms per deciliter (µg/dL) based on the recommendation by EPA (EPA, 2017a). Additionally, recently updated default lead intake values through food consumption were used in the model (Table 3). Further, following current EPA guidance (EPA, 2017b), the default age range of 0 to 84 months was modified to 12 to 72 months based on the U.S. Centers for Disease Control and Prevention's recommendation. Tables 2 and 3 summarize the general and age-specific IEUBK input parameter values used in the analysis.

[1] The higher EPC between unsieved and sieved sediment data is used as the final EPC.

[2] The "total" (rather than "dissolved") lead concentration is used as the EPC.

[3] The IEUBK model does not address sediment and surface water specifically but does address soil and drinking water. Therefore, sediment was addressed as soil and surface water was addressed as drinking water in the model.

The IEUBK model results are expressed as the predicted geometric mean (GM) BLL for children and the percentage of the child population with potential BLLs above the target BLL. Based on the EPA Office of Land and Emergency Management (OLEM) policy (EPA, 1994), which strives to reduce lead exposure levels so that there is no more than a 5 percent probability that children exposed to lead will exceed a BLL of 10 µg/dL, 10 µg/dL was used as a target BLL. Additionally, the current scientific literature on lead toxicology and epidemiology provides evidence that adverse health effects are associated with BLLs less than 10 µg/dL (EPA, 2016). Therefore, lead exposure was assessed using two additional, lower target BLLs (5 and 8 µg/dL) based on consultation with EPA Region 6.

IEUBK output is presented in Attachment B.

E.2.2 Adult Lead Methodology

An interim approach to assessing potential risks associated with adult exposures to lead was developed by EPA's TRW for Lead (EPA, 2003a) and updated in 2017 (EPA, 2017c). This methodology is a variation of the IEUBK model. The Adult Lead Methodology (ALM) model is used to evaluate potential risks to fetuses of women exposed to lead in non-residential settings. The model estimates fetal BLLs in pregnant women exposed to lead in soil (EPA, 2003a).[4]

Because the ALM is a probabilistic model, the arithmetic mean lead concentration was used as the EPC, consistent with EPA guidance (EPA, 2003a). Additionally, central tendency values for ingestion rate and exposure frequency were estimated and used in the ALM model. Without specific information regarding sediment ingestion rate for aquatic workers, an ingestion rate of 100 milligrams per day (mg/day), equal to EPA's default adult reasonable maximum exposure (RME) residential soil ingestion rate (EPA, 2014), was used as a conservative CTE ingestion rate. Additionally, an exposure frequency of 219 days per year (days/year) was assumed for the aquatic worker, as recommended in the ALM frequently asked questions[5]. This value is a CTE estimate for non-residential exposure scenarios (i.e., both commercial and industrial), and corresponds to the average time spent at work by both full- and part-time workers engaged in non-contact-intensive activities. The geometric standard deviation (GSD) and baseline BLLs from the most recent 6 years (2009 to 2014) of data from the National Health and Nutrition Examination Survey, as recommended by EPA (2017a), were used in the ALM model.

The ALM model was used to calculate potential BLLs for the aquatic worker scenario. The model results are expressed as the predicted GM BLL, the corresponding 95th percentile fetal BLLs, and the probability that fetuses exposed to lead will exceed a BLL above the same set of target BLLs (5, 8, and 10 µg/dL) used in the IEUBK model.

ALM output is presented in Attachment C.

E.3 Risk Characterization

E.3.1 Results of Evaluation

E.3.1.1 IEUBK

The estimated probabilities that children exposed to lead will exceed a target BLL of 5 µg/dL, as summarized in Table 4, were greater than 5 percent for all watersheds except Neosho River and Lost Creek. Note that statistical tests (central tendency tests) indicate that both sediment and surface water concentrations in Neosho River and Lost Creek are comparable to background (CH2M, 2020).

[4] The ALM model does not address sediment specifically, but does address soil. Therefore, sediment was addressed as soil in the model.

[5] https://www.epa.gov/superfund/lead-superfund-sites-frequent-questions-risk-assessors-adult-lead-methodology#industrial%20worker

The estimated probabilities that children exposed to lead will exceed target BLLs of 8 and 10 µg/dL were less than 5 percent for two additional watersheds (Beaver Creek and Lower Spring River).

E.3.1.2 ALM

The estimated probabilities that fetuses exposed to lead will exceed target BLLs of 5 and 8 µg/dL, as summarized in Table 4, were greater than 5 percent for two watersheds (Elm Creek and Tar Creek). Of these two watersheds, the estimated probability that fetuses exposed to lead will exceed a target BLL of 10 µg/dL was less than 5 percent for Tar Creek. The estimated probabilities that fetuses exposed to lead will exceed target BLLs of 5, 8, and 10 µg/dL were less than 5 percent for the other four watersheds (Neosho River, Beaver Creek, Lost Creek, and Lower Spring River).

E.3.2 Conclusion

Based on the initial IEUBK (using the default IEUBK input parameter values for children) and ALM (using a conservatively estimated CTE sediment ingestion rate and exposure frequency for aquatic workers) analyses of lead exposure, lead was identified as a preliminary chemical of concern (COC) in the following watersheds:

- Tribal lifeway child – Elm Creek, Tar Creek, Beaver Creek, and Lower Spring River (further analysis of lead was performed in the uncertainty analysis below)
- General public child – Elm Creek, Tar Creek, Beaver Creek, and Lower Spring River
- Aquatic worker – Elm Creek and Tar Creek

E.4 Uncertainty Analysis

E.4.1 Additional Analysis for Tribal Lifeway Children Based on RME Values

An additional analysis of potential lead exposure was performed using RME input parameter values. RME values were used in this additional analysis as high-end exposure estimates to avoid the extensive effort to develop CTE values representative of specific tribal lifeway exposure scenarios. It is acknowledged that there are considerable uncertainties associated with the use of these RME parameter values in the IEUBK model since the model is designed to predict the cumulative distribution of BLLs based on CTE parameter values. However, this additional analysis was performed so that, in combination with the results of the initial analysis, a range of potential lead exposure and risk outcomes could be evaluated.

E.4.1.1 Approach

For the additional analysis using the IEUBK model for tribal lifeway children, the focus was on three key exposure pathways (sediment ingestion, drinking water ingestion, and food consumption [i.e., dietary intake]) considered to be the most significant exposure pathways for the tribal lifeway exposure scenario and the most influential on model output. Consistent with the RME values identified in the HHRA (Appendix B, RAGS Table 4 series), the following RME input parameter values were used in the additional analysis:

- Soil/dust (sediment) – RME sediment ingestion rate of 400 mg/day (adapted from Harper, 2008).
- Drinking water – RME drinking water ingestion rate of 0.78 liter per day (EPA, 2014).
- Diet – Lead intake from consumption of aquatic food obtained from the OU5 study area was estimated based on adult ingestion rates (Harper, 2008) and EPA's Exposure Factors Handbook and updates (EPA, 2011, 2018a, 2018b). The detailed approach and assumptions used in the calculation of lead intake through food consumption are presented in Table 5.

Table 3 summarizes the RME values used in the additional analysis in comparison to the default IEUBK model values used in the initial analysis. The additional analysis was performed using the same sediment and surface water EPCs used in the initial analysis and a target BLL of 5 µg/dL.

E.4.1.2 Results

The IEUBK model predicted a geometric mean BLL above 30 µg/dL (which is above the level that can be analyzed by the IEUBK model) for all six watersheds, as well as Fourmile Creek which was selected as a background or reference location (Table 6). The IEUBK model is not validated at levels above a geometric mean BLL of 30 µg/dL, however, and the results should be evaluated with caution. The results do not reflect the actual magnitude of the risk. That is, a higher intake rate does not mean a higher BLL. Observational data indicates that there is a non-linear relationship (curvilinear relationship) between intake rate (micrograms per day) and BLL. Although there is a considerable degree of uncertainty associated with the conservative nature of RME assumptions used in this additional analysis, lead cannot be excluded as a preliminary COC based on the results of the additional analysis. Therefore, lead was identified as a preliminary COC for all six watersheds.

E.4.2 Time-Weighted Average Analysis of Lead Exposure for General Public Children

General public children were assumed to contact sediment and surface water at an exposure frequency of 28 days/year under a recreational user scenario (in comparison to the tribal lifeway exposure frequency of 312 days/year). Because of this low frequency of exposure, an evaluation of lead EPCs based on time-weighted average (TWA) concentrations accounting for exposure outside of the OU5 study area (i.e., at residential yards) was conducted to estimate potential impacts on IEUBK model results.

E.4.2.1 Approach

First, an attempt was made to estimate acceptable lead concentrations in soil/sediment for each watershed using the IEUBK model. The acceptable lead concentrations in soil/sediment, corresponding to the probability that 5 percent of exposed children will exceed the target BLL of 5 µg/dL, were estimated for each watershed based on its surface water EPC[6] (as the drinking water EPC) and default IEUBK input parameter values.

Second, while the sediment EPC for each watershed was kept as a fixed value, TWA concentrations were estimated for various combinations of the three variables below:

- Exposure time spent at an OU5 study area water body: 0.5 and 1 hour
- Exposure frequency to visit an OU5 study area water body: 1 and 2 days/week
- Lead concentration in residential yard: 50, 120, 250, and 400 milligrams per kilogram (mg/kg)

Lastly, each TWA concentration was compared to the modeled acceptable soil/sediment lead concentration to identify which combinations of the three variables achieve the acceptable lead concentrations.

The TRW has recommended that the IEUBK model and the ALM be applied to exposures that exceed a minimum frequency of 1 day per week (day/week) and a duration of 3 consecutive months (EPA, 2003b). As discussed in Appendix B, RAGS Table 4.1, the exposure frequency of 28 days/year was selected for general public receptors, assuming 1 day/week of exposure during the 7 months between April and October. Based on the TRW's recommendation, two exposure frequencies were used to

[6] Although as lead concentrations in soil/sediment decrease, lead concentrations in surface water are expected to decrease proportionally, current surface water EPCs were used as drinking water EPCs without an established correlation between sediment and surface water lead concentrations.

calculate TWA concentrations (1 day/week and 2 days/week). An exposure frequency higher than 2 days/week was not used because assuming even the shortest exposure duration of 3 months (or roughly 13 weeks), an exposure frequency of 3 days/week (corresponding to an annual exposure frequency of 39 days/year) would exceed the RME exposure frequency of 28 days/year.

E.4.2.2 Results

Due to elevated lead concentrations in surface water, no acceptable soil/sediment concentrations were established for Elm Creek and Tar Creek; lead intake through drinking water alone exceeds the acceptable level. For Beaver Creek and Lower Spring River, 59 mg/kg and 123 mg/kg, respectively, were calculated as acceptable soil/sediment concentrations based on their respective surface water EPCs and default IEUBK input parameter values (Table 7). Evaluation of TWA was not performed for Neosho River and Lost Creek because the results of the initial analysis already indicate that concentrations of lead in sediment and surface water in these two watersheds are acceptable.

TWA concentrations calculated based on various combinations of the three variables indicated that the range of exposure time and exposure frequency values has little impact on the calculated TWA concentrations (Table 8). Because of the short exposure time and infrequent exposure to sediment at the OU5 study area, soil concentrations in residential yards control the TWA concentrations. Therefore, the lead concentration in OU5 study area sediment has little impact on TWA concentrations. EPCs based on TWA concentrations accounting for exposure outside of the OU5 study area (i.e., residential yards) could result in lower BLLs only when lead concentrations in residential yards are approximately the same as the calculated acceptable lead concentration in soil/sediment.

E.4.3 Analysis of Dissolved Lead Concentrations in Surface Water

Dissolved lead concentrations in surface water were noticeably lower than total lead concentrations. Statistical comparisons of site data with background levels indicated that dissolved lead concentrations in surface water in all watersheds except Tar Creek are comparable to background (Table 1). Therefore, if receptors used a water treatment system on their drinking water supply (assumed to be surface water in the HHRA), their lead exposure through potable use of surface water would be lower than that predicted based on total lead concentrations in surface water.

E.4.4 Limitations of IEUBK/ALM Model Exposure Scenarios

Various potentially complete exposure pathways and scenarios were identified and evaluated in the HHRA for the receptors identified at the OU5 study area. However, all pathways and scenarios were not addressed in the lead exposure analysis using the IEUBK or ALM models presented in this appendix due to limitations associated with the models. For instance, although lead exposure through dermal contact was not evaluated in either model, this exposure route is not considered to be the primary route of exposure for lead. Additionally, potential additional lead exposure during sweat lodge use for tribal lifeway children (ingestion, dermal contact, and inhalation) and through incidental ingestion and dermal contact to surface water during hunting/fishing/gathering and recreational activities was not included in the analysis. Table 9 summarizes the exposure pathways and scenarios addressed in the lead exposure analysis and qualitative assessment of potential impact from not including some of the exposure pathways and scenarios. Although there are limitations associated with the lead exposure analysis performed using the IEUBK and ALM models, lead is identified as a preliminary COC for all watersheds, including those with lead in sediment and surface water at levels comparable to background levels. Therefore, the purpose of the lead analysis (i.e., to identify potential unacceptable risk associated with exposure to lead in environmental media within the OU5 study area) was adequately achieved.

E.5 Conclusions

Based on the results of the initial and additional lead exposure analysis, lead was conservatively identified as a preliminary COC in sediment and surface water for all six watersheds under the tribal lifeway child scenario. Based on the results of the initial lead exposure analysis, lead was identified as a preliminary COC in sediment for two watersheds (Elm Creek and Tar Creek) under the aquatic worker scenario. Lead was also identified as a preliminary COC in sediment and surface water in two additional watersheds (Beaver Creek and Lower Spring River) under the general public child scenario. Please note that sediment and surface water EPCs in these two watersheds are below the screening levels identified in Section 3.2 of the HHRA; however, lead was conservatively identified as a preliminary COC for these watersheds under the general public child scenario.

Consistent with Section 6.4 of the HHRA, a refinement of lead as a final COC was conducted based on the results of background comparisons. Although COC refinement was performed for other metals using a two-step process, the second step of the refinement process (i.e., elimination of preliminary COCs based on the nature of mine-related contamination) was not performed for lead because lead is a primary COC at the OU5 study area. Based on the results of background comparisons, lead was eliminated as a final COC from Neosho River and Lost Creek because statistical background comparisons (central tendency) indicate that lead concentrations in sediment and surface water at these watersheds are not greater than background. The list of watersheds where lead is identified as a final COC is summarized in Table 10.

As stated in Section E.1, the purpose of this lead analysis is to identify potential unacceptable risk associated with exposure to lead in OU5 environmental media. The biokinetic models were run as a tool to determine if lead poses unacceptable risk to potential human receptors at OU5 rather than to characterize the magnitude of potential exposure. The streamlined approach was taken because of limitations of the IEUBK model in assessing specific tribal exposure scenarios and the goal of efficiently determining whether lead is a preliminary COC without expending considerable effort in identifying specific exposure parameter values characterizing unique OU5 study area exposure scenarios. The objective was reviewed by EPA's Technical Review Workgroup Lead Committee. Although a considerable degree of uncertainty associated with use of high-end exposure assumptions (e.g., food and sediment ingestion rates that are far above CTE values) and the conservative approach taken in the analyses was acknowledged, the primary objective of the lead analysis at this stage of the investigation was accomplished. The preliminary remediation goal for lead, which is a risk-based concentration accounting for the magnitude of potential exposure, will be identified in the feasibility study stage of the project.

E.6 References

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Tables

Appendix E, Table 1. Summary of Lead Analytical Data

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

			Frequency of Detection			Minimum Values		Maximum Values				SL Comparison					Background Threshold Value		Background Comparison		
Watershed	Matrix[a]	Sample/ Analysis Type	Number of Total Samples	Number of Detected Results	Detect Frequency (%)	Non-Detect	Detect	Non-Detect	Detect	Average Concentration[b]	EPC	SL	Maximum Detected Concentration Exceeds SL?	EPC (Average Concentration) Exceeds SL?	No. of Detected Concentrations Exceeding SL	Percent of Detected Concentrations Exceeding SL	UTL95-95[c]	Basis	No. of Results Exceeding BTV (1/2 RL)[d]	Percent of Results Exceeding BTV (1/2 RL)[d]	Site Sample Population Exceeds Background[c]
Elm Creek	SED	Sieved	9	9	100	--	73.2	--	1,200	367	4,281	400	Yes	Yes	2	22	44.2	Normal	9	100	Yes
		Unsieved	32	32	100	--	15.2	--	40,400	4,281			Yes		15	47	58.4	Normal	26	81	Yes
	SW	Total	44	38	86	0.0002	0.0011	0.0050	0.446	0.064	0.064	0.015	Yes	Yes	28	74	0.0050	Nonparametric	36	82	Yes
		Dissolved	34	9	26	0.0025	0.0003	0.0050	0.0224	0.0046	--	--	--	--	--	--	0.0090	Nonparametric	3	9	No
Tar Creek	SED	Sieved	98	98	100	--	18.1	--	7,280	1,095	1,095	400	Yes	Yes	54	55	44.2	Normal	84	86	Yes
		Unsieved	101	101	100	--	14.5	--	4,940	532			Yes		34	34	58.4	Normal	88	87	Yes
	SW	Total	967	870	90	0.0003	0.0003	0.0050	1.31	0.037	0.037	0.015	Yes	Yes	653	75	0.0050	Nonparametric	792	82	Yes
		Dissolved	419	217	52	0.0001	0.0001	0.0050	0.141	0.019	--	--	--	--	--	--	0.0090	Nonparametric	125	30	Yes
Neosho River	SED	Sieved	6	6	100	--	14.1	--	104	38	38	400	No	No	0	0	44.2	Normal	1	17	No
		Unsieved	17	15	88	5.00	10.0	5.00	31.8	13			No		0	0	58.4	Normal	0	0	No
	SW	Total	59	11	19	0.0003	0.0004	0.0050	0.0210	0.0045	0.0045	0.015	Yes	No	3	27	0.0050	Nonparametric	6	10	No
		Dissolved	81	7	9	0.0002	0.0018	0.0050	0.0304	0.0038	--	--	--	--	--	--	0.0090	Nonparametric	1	1	No
Beaver Creek	SED	Sieved	16	16	100	--	47.2	--	877	275	275	400	Yes	No	3	19	44.2	Normal	16	100	Yes
		Unsieved	22	22	100	--	11.4	--	586	95			Yes		1	5	58.4	Normal	10	45	Yes
	SW	Total	100	70	70	0.0003	0.0002	0.0050	0.101	0.011	0.011	0.015	Yes	No	19	27	0.0050	Nonparametric	44	44	Yes
		Dissolved	51	17	33	0.0003	0.0002	0.0050	0.0094	0.0031	--	--	--	--	--	--	0.0090	Nonparametric	1	2	No [e]
Lost Creek	SED	Sieved	10	10	100	--	6.00	--	1,450	168	168	400	Yes	No	1	10	44.2	Normal	3	30	No
		Unsieved	37	37	100	--	7.61	--	1,520	124			Yes		3	8	58.4	Normal	7	19	No
	SW	Total	65	14	22	0.0002	0.0003	2.50	0.0120	0.118	0.0027[f]	0.015	No	No	0	0	0.0050	Nonparametric	4	6	No
		Dissolved	27	0	0	0.0005	--	0.0050	--	--	--	--	--	--	--	--	0.0090	Nonparametric	0	0	No
Lower Spring River	SED	Sieved	67	67	100	--	7.70	--	810	146	146	400	Yes	No	6	9	44.2	Normal	47	70	Yes
		Unsieved	48	48	100	--	15.5	--	1,060	108			Yes		2	4	58.4	Normal	26	54	Yes
	SW	Total	104	48	46	0.0003	0.0005	0.0050	0.0670	0.0062	0.0062	0.015	Yes	No	8	17	0.0050	Nonparametric	18	17	No
		Dissolved	76	8	11	0.0002	0.0002	0.0050	0.0709	0.0050	--	--	--	--	--	--	0.0090	Nonparametric	3	4	No
Fourmile Creek (Reference)	SED	Sieved	23	23	100	--	15.50	--	38	27	27										
		Unsieved	11	11	100	--	9.3	--	53	24											
	SW	Total	50	39	78	0.0001	0.0001	0.0050	0.0050	0.0024	0.0024										
		Dissolved	51	11	22	0.0001	0.0002	0.0050	0.0090	--	--										

Notes:

Units for concentrations in sediment are presented in mg/kg and concentrations in surface water are presented in mg/L.

[a] Matrix: SED - sediment; SW - surface water

[b] Average concentrations were used as EPCs. When lead was not detected, one-half the reporting limit was used in the calculation.

[c] UTLs were calculated as 95% upper confidence bounds of the 95th percentiles of the background data (presented in Section 6 tables from the RI report). UTLs calculated without a definitive distributional assumption of the data (i.e., normal, gamma, or lognormal) have a coverage probability less than 95%.

[d] Comparisons of individual site sample concentrations to background threshold values were conducted assuming one-half the reporting limit for non-detects.

[e] Additional statistical analysis indicates that site and background concentrations are comparable.

[f] Eliminated three high non-detected results from the calculation of EPC.

-- = not available/not applicable

Acronyms:

BTV = background threshold value

EPC = exposure point concentration

RI = remedial investigation

RL = reporting limit

SL = screening level

UTL = upper tolerance limit

UTL95-95 = 95% upper tolerance limit with 95% coverage

Units:

mg/L = milligrams per liter

mg/kg = milligrams per kilogram

Appendix E, Table 2. Summary of General IEUBK Input Parameter Values Used in the Analyses

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Parameter	Value	Basis
Soil concentration (mg/kg)	Site-specific	EPC sediment concentration (mean concentrations)
Dust concentration (mg/kg)	0.7 x (soil concentration) + (air concentration x 100)	IEUBK Default. Indoor dust lead is derived using multiple source analysis
Outdoor air concentration (µg/m^3)	0.1	IEUBK Default (EPA, 1994b, 2007)
Indoor air concentration (µg/m^3)	30% of outdoor air concentration	IEUBK Default (EPA, 1994b)
Drinking water concentration (µg/L)	Site-specific	EPC surface water concentration (mean concentrations)
Maternal BLL at birth (µg/dL)[a]	0.6	Based on National Health and Nutrition Examination Survey (NHANES) update (2009-2014) (EPA, 2017)
Absorption fractions at low intakes:		IEUBK Default (EPA, 1994b)
Air (lung absorption)	32%	
Soil/dust	30%	
Water	50%	
Diet	50%	
Soil/dust ingestion weighting factor (percent soil)	45%	EPA, 1994b
Geometric standard deviation	1.6	EPA, 1994b
Target BLL (µg/dL)	5, 8, and 10	10 µg/dL is based on EPA, 2016. The lower target BLLs (5 and 8 µg/dL) also evaluated for comparison.

Note:

[a] Maternal BLL at birth does not impact results for the 12- to 72-month age range.

Acronyms:

BLL = blood lead level

EPA = U.S. Environmental Protection Agency

EPC = exposure point concentration

IEUBK = Integrated Exposure Uptake Biokinetic

OLEM = Office of Land and Emergency Management

OSWER = Office of Solid Waste and Emergency Response

Units:

µg/dL = micrograms per deciliter

µg/L = micrograms per liter

µg/m^3 = micrograms per cubic meter

mg/kg = milligrams per kilogram

References:

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Appendix E, Table 3. Summary of Age-Specific IEUBK Input Parameter Values Used in the Analyses

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Exposure Medium[a]	Parameter	Age Group (years old)[a]					Source	Analysis
		1 to <2	2 to <3	3 to <4	4 to <5	5 to <6		
Soil/Dust	Soil/Dust Ingestion Rate (g/day)	0.094	0.067	0.063	0.067	0.052	IEUBK default [b]	Initial
	(Using Sediment)	0.4	0.4	0.4	0.4	0.4	Harper, 2008	Additional
Drinking Water	Water Consumption (L/day)	0.43	0.51	0.54	0.57	0.6	IEUBK default [b]	Initial
	(Using Surface Water)	0.78	0.78	0.78	0.78	0.78	EPA, 2014	Additional
Diet	Lead Intake through Food	5.03	5.21	5.38	5.64	6.04	IEUBK default [b]	Initial
	(µg Pb/day)	3,582	3,879	4,657	4,657	4,658	Calculated (see Table 5)[c]	Additional
Air	Time Outdoors (hours)	2.0	3.0	4.0	4.0	4.0	IEUBK default [b]	Initial and Additional
	Ventilation Rate (m^3/day)	4.97	6.09	6.95	7.68	8.32		

Notes:

[a] The lead exposure parameter values for children (12 to 72 months old only) per OLEM Directive 9200.2 177 (EPA, 2017).

[b] Recent update not yet published by EPA provided to CH2M directly by EPA Region 6.

[c] The values were calculated based on ingestion rates in Harper (2008), EPA EFH and updates (EPA, 2011, 2018a, 2018b), and site-specific data.

Acronyms:

EPA = U.S. Environmental Protection Agency

EFH = Exposure Factors Handbook

IEUBK = Integrated Exposure Uptake Biokinetic

OLEM = Office of Land and Emergency Management

OSWER = Office of Solid Waste and Emergency Response

RME = reasonable maximum exposure

Units:

µg Pb/day = micrograms of lead per day

g/day = grams per day

L/day = liters per day

m^3/day = cubic meters per day

References:

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Appendix E, Table 4. Summary of Lead Exposure Analysis Using IEUBK and ALM Models in the Initial Analysis

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Receptor	Model	Parameter Value		Watershed						
				Fourmile Creek (reference)	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
Tribal Lifeway Child/ General Public Child	IEUBK[a]	Sediment EPC (mg/kg)[c,d]		27.1	4,281	1,095	37.8 †	275	168 †	146
		Surface Water EPC (µg/L)[c,e]		2.4	63.6	36.8	4.5 †	10.6	2.7 †,[f]	6.2 †
		GM BLL (µg/dL)		1	21	9	2	4	2	2
		% Above	5 µg/dL	0.33	99.9 *	91.1 *	0.9	23.4 *	4.7	6.4 *
			8 µg/dL	0.01	98.1 *	63.7 *	0.04	4.21	0.38	0.58
			10 µg/dL	0.001	94.5 *	45.0 *	0.006	1.38	0.08	0.14
Aquatic Worker	ALM[b]	Sediment EPC (mg/kg)[c]		27.1	4,281	1,095	37.8 †	275	168 †	146
		GM BLL (µg/dL)		0.68	13	4	0.71	1.4	1.1	1.0
		% Above	5 µg/dL	0.02	92.5 *	25.2 *	0.02	0.93	0.27	0.20
			8 µg/dL	< 0.001	73.8 *	7.12 *	< 0.001	0.080	0.017	0.012
			10 µg/dL	< 0.001	60.2 *	3.24	< 0.001	0.020	0.004	0.002

Notes:

[a] Analysis of lead exposure was performed for child receptors using the IEUBK model based on the site-specific sediment and surface water EPCs.

Sediment EPCs were used as soil EPCs, while surface water EPCs were used as drinking water EPCs.

Default values were used for the other IEUBK input parameter values.

[b] Analysis of lead exposure was performed for aquatic workers using the ALM model based on the site-specific sediment EPCs.

A central tendency soil (sediment) ingestion rate of 100 mg/day and exposure frequency of 219 days/year were used for the aquatic worker.

The GSD and baseline BLL from the most recent 6 years (2009-2014) of blood lead data from the NHANES were used in the ALM model.

[c] Average concentrations were used as EPCs.

[d] Sediment EPCs were calculated for unsieved and sieved datasets separately and the higher of the two was used as the final EPC.

[e] Total metal data were used.

[f] Eliminated three high non-detected results from the calculation of EPC.

† No statistically significant difference from background.

* Greater than the target probability of 5%.

Acronyms:

ALM = Adult Lead Methodology

BLL = blood lead level

EPC = exposure point concentration

GM = geometric mean

GSD = geometric standard deviation

IEUBK = Integrated Exposure Uptake Biokinetic

NHANES = National Health and Nutrition Examination Survey

Units:

µg/dL = micrograms per deciliter

µg/L = micrograms per liter

mg/kg = milligrams per kilogram

Appendix E, Table 5. Estimation of Dietary Lead Intake Levels for Tribal Lifeway Child

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Age Group (Vegetable and Meat)	Body Weight Table 8-1 (EPA, 2011)	Total Vegetable[a]			Total Meat[a]			Age Group (Aquatic)	Finfish[a]			Shellfish[a]		
		Table 9-3 (EPA, 2018a)		Child/Adult Fraction	Table 11-3 (EPA, 2018b)		Child/Adult Fraction		Table 10-8 (EPA, 2011)		Child/Adult Fraction	Table 10-10 (EPA, 2011)		Child/Adult Fraction
		(g/kg-day)	(g/day)[b]	(Unitless)[c]	(g/kg-day)	(g/day)[b]	(Unitless)[c]		(g/kg-day)	(g/day)[b]	(Unitless)[c]	(g/kg-day)	(g/day)[b]	(Unitless)[c]
	Mean (kg)	Mean	Mean		Mean	Mean			Mean	Mean		Mean	Mean	
1 to <2 years	11.4	6.65	75.8	0.38	3.94	44.9	0.31	1 to 2 years	1.61	18.4	0.35	0.94	10.7	0.21
2 to <3 years	13.8	5.95	82.1	0.41	4.17	57.5	0.40	3 to 5 years	1.28	17.7	0.34	1.00	13.8	0.27
3 to <6 years	18.6	5.30	98.6	0.49	3.96	73.7	0.51	6 to 12 years	1.05	19.5	0.38	0.72	13.4	0.27
Adult														
21 to < 50 years	80	2.52	202	--	1.79	143	--	20 to < 50 years	0.65	52.0	--	0.63	50.4	--

Age Group		Summary of Child/Adult Fraction (unitless)[c]						Food Consumption Rate (g/day)					
		Fish	Shellfish	Aquatic Reptile/ Amphibian	Semi-Aquatic Mammal	Aquatic Plant		Fish	Shellfish	Aquatic Reptile/ Amphibian	Semi-Aquatic Mammal	Aquatic Plant	Ref
Years	Months						Adult[e]	90	30	24	69	133	Harper, 2008
1 to <2 years	12-24	0.35	0.21	0.21	0.31	0.38		31.77	6.38	5.10	21.64	50.01	
2 to <3 years	24-36	0.35	0.21	0.21	0.40	0.41		31.77	6.38	5.10	27.73	54.17	
3 to <4 years	36-48	0.34	0.27	0.27	0.51	0.49	Child[f]	30.57	8.21	6.57	35.49	65.04	
4 to <5 years	48-60	0.34	0.27	0.27	0.51	0.49		30.57	8.21	6.57	35.49	65.04	
5 to <6 years	60-72	0.38	0.27	0.27	0.51	0.49		33.80	7.97	6.38	35.49	65.04	

Age Group			Lead EPC in Food Items[g]	Fish	Shellfish	Aquatic Reptile/ Amphibian	Semi-Aquatic Mammal	Aquatic Plant	Total (µg/day)
Years	Months		(mg/kg or µg/g)	0.365	1.94	0.477	0.514	70.9	
1 to <2 years	12-24			11.581	12.398	2.435	11.129	3543.960	3,582
2 to <3 years	24-36		Lead intake[h]	11.581	12.398	2.435	14.258	3838.471	3,879
3 to <4 years	36-48		(µg/day)	11.146	15.966	3.136	18.250	4608.410	4,657
4 to <5 years	48-60			11.146	15.966	3.136	18.250	4608.410	4,657
5 to <6 years	60-72			12.323	15.494	3.043	18.250	4608.410	4,658

Notes:

[a] Information about age-specific body weight and food consumption rates was obtained from EPA Exposure Factors Handbook.

[b] Body weight adjusted food consumption rates (in g/kg-day) in the EFH are converted to consumption rates in grams per day by multiplying by age-specific body weight.

[c] Child/Adult fractions were calculated by dividing child food consumption rate by adult food consumption rate.

[d] Summary of Child/Adult fractions used to estimate age-specific child food consumption rates.

Fish - Child/Adult fractions based on finfish data.

Shellfish and Frog - Child/Adult fractions based on shellfish data.

Mammal - Child/Adult fractions based on total meat data.

Plant - Child/Adult fractions based on total vegetable data.

[e] RME food ingestion rates established for tribal lifeway adult based on Harper (2008). See Tables 4.6 and 4.7 RME.

[f] Food consumption rates for child were calculated by multiplying adult food consumption rate by Child/Adult fraction.

[g] Lead EPC (average concentrations) are presented in Tables 3.5 through 3.11 RME.

[h] Lead intake through food consumption was estimated by multiplying food consumption rates by lead EPC.

Acronyms:

EPA = U.S. Environmental Protection Agency

EPC = exposure point concentration

EFH = Exposure Factors Handbook

RME = reasonable maximum exposure

Units:

µg/day = micrograms per day

µg/g = micrograms per gram

g/day = grams per day

g/kg-day = grams per kilogram per day

mg/kg = milligrams per kilogram

References:

EPA. 2011. Exposure Factors Handbook: 2011 Edition. PA/600/R-09/052F. September.

EPA. 2018a. Update for Chapter 9 of the Exposure Factors Handbook. Intake of Fruits and Vegetables. EPA/600/R-18/098F. August.

EPA. 2018b. Update for Chapter 11 of the Exposure Factors Handbook. Intake of Meats, Dairy Products, and Fats. EPA/600/R-17/485F. August.

Harper. 2008. Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc.

Appendix E, Table 6. Summary of Additional Lead Exposure Analysis for Tribal Lifeway Child Using IEUBK Model

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Receptor	Model	Parameter Value	Watershed						
			Fourmile Creek (reference)	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
Tribal Lifeway Child	IEUBK[a,b]	Sediment EPC (mg/kg)[c,d]	27.1	4281	1095	37.8 †	275	168 †	146
		Surface Water EPC (µg/L)[c,e]	2.4	63.6	36.8	4.5 †	10.6	2.7 †,[f]	6.2 †
		GM BLL (µg/dL)	126 **	142 **	131 **	126 **	128 **	127 **	127 **

Notes:

[a] Analysis of lead exposure was performed for child receptors using the IEUBK model based on the site-specific sediment and surface water EPCs.

Sediment EPCs were used as soil EPCs, while surface water EPCs were used as drinking water EPCs.

[b] RME values (presented for Additional Analysis in Appendix E Table 3) were used for the soil ingestion, drinking water, and food consumption exposure pathways.

[c] Average concentrations were used as EPCs.

[d] Sediment EPCs were calculated for unsieved and sieved datasets separately and the higher of the two was used as the final EPC.

[e] Total metal data were used.

[f] Eliminated three high non-detected results from the calculation of EPC.

† No statistically significant difference from background.

** Greater than the IEUBK Model BLL limit of 30 µg/dL. It should be noted that the IEUBK model is not validated at levels above GM BLL of 30 µg/dL and should be evaluated with caution. The results do not reflect the actual magnitude of the risk. That is, the higher intake rate does not mean higher BLL. Observational data indicate that there is a non-linear relationship (curvilinear relationship) between intake rate (µg/day) and BLL.

Acronyms:

BLL = blood lead level

EPC = exposure point concentration

GM = geometric mean

IEUBK = Integrated Exposure Uptake Biokinetic

RME = reasonable maximum exposure

Units:

µg/dL = micrograms per deciliter

µg/L = micrograms per liter

mg/kg = milligrams per kilogram

Appendix E, Table 7. Summary of Estimated Acceptable Soil/Sediment Concentrations

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Receptor	Model	Parameter Value	Watershed[e]						
			Fourmile Creek (reference)	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
General Public	IEUBK[a]	Surface Water EPC (µg/L)[b,c]	2.4	63.6	36.8	4.5 †	10.6	2.7 †, [f]	6.2 †
Child		Acceptable Soil/Sediment (mg/kg)	176	too high[d]	too high[d]	146 [e]	59	173 [e]	123
Presented for reference		Sediment EPC (mg/kg)	27.1	4,281	1,095	37.8 †	275	168 †	146

Notes:

[a] The acceptable soil/sediment concentrations corresponding to 5% of population exceeding BLL of 5 µg/dL were estimated using the IEUBK model. Although as lead concentrations in soil/sediment decrease, lead concentrations in surface water are expected to decrease proportionally, surface water EPCs were retained to be used as drinking water EPCs, while default values were used for the other input parameters in the IEUBK Model.

[b] Average concentrations were used as EPCs.

[c] Total metal data were used.

[d] No acceptable soil/sediment concentration can be achieved due to high concentration of lead in drinking water (surface water). Lead intake from drinking water (surface water) pathway is too high to achieve the lead exposure goal.

[e] Sediment concentrations in Neosho River and Lost Creek are already lower than the acceptable soil/sediment concentrations without using time-weighted average.

† No statistically significant difference from background.

Acronyms:

µg/L = micrograms per liter

BLL = blood lead level

EPC = exposure point concentration

IEUBK = Integrated Exposure Uptake Biokinetic

mg/kg = milligrams per kilogram

Appendix E, Table 8. Calculation of Time-Weighted Average Concentrations

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

			General Public: Time-Weighted Average (PbS_w [mg/kg])[1]			
		Watershed	Beaver Creek		Lower Spring River	
Exposure Time (hr/day)	PbS_yard (mg/kg)	PbS_site (mg/kg)	275		146	
		Exposure Frequency (days/wk)	1 day/week	2 days/week	1 day/week	2 days/week
ET = 0.5 hour	50		54	58	52	53
	120		***123***	***126***	120	121
	250		***250***	***251***	***248***	***246***
	400		***398***	***396***	***395***	***391***
ET = 1 hour	50		58	66	53	57
	120		***126***	***131***	121	122
	250		***251***	***252***	***246***	***243***
	400		***396***	***391***	***391***	***382***
Acceptable Soil/Sediment Concentrations (mg/kg)				59		123

Exposure Time (time spent outdoor)			Exposure Frequency			
ET_site (hours)	F_site (unitless)	F_yard (unitless)	EF_site (unitless)	EF_yard (unitless)	EF_site (unitless)	EF_yard (unitless)
			1 day/week		2 days/week	
0.5	0.125	0.875	0.14	0.86	0.29	0.71
0.5	0.125	0.875	0.14	0.86	0.29	0.71
0.5	0.125	0.875	0.14	0.86	0.29	0.71
0.5	0.125	0.875	0.14	0.86	0.29	0.71
1	0.25	0.75	0.14	0.86	0.29	0.71
1	0.25	0.75	0.14	0.86	0.29	0.71
1	0.25	0.75	0.14	0.86	0.29	0.71
1	0.25	0.75	0.14	0.86	0.29	0.71
IEUBK default time spent outdoor			4	hr/day		

Notes:

Equation[1]: PbS_w = EF_site x [(F_site x PbS_site) + (F_yard x PbS_yard)] + (EF_yard x PbS_yard)

Where:

EF_site = Fraction of year (exposure frequency) at which a child visits the site (days/week).

EF_yard = Fraction of year (exposure frequency) child does not visit the site (EF_yard = 1 - EF_site) (unitless).

F_site = Fraction of daily outdoor time spent at OU5 site. The IEUBK lead model default value for total time spent by a child 0 to 6 years old playing outdoors is limited to 4 hours (unitless).

F_yard = Fraction of outdoor time a child spends in their yard (F_yard = 1 - F_site) (unitless).

PbS_site = Average sediment lead concentration at the site (mg/kg).

PbS_w = TWA soil lead concentration (mg/kg).

PbS_yard = Average soil concentration in their yard (mg/kg).

Exceed Exceeds acceptable Soil/Sediment Concentration

It was simply assumed that when the receptor is not spending time at OU5, they spend their time at their residential yard.

hr/day = hours per day

mg/kg = milligrams per kilogram

Appendix E, Table 9. Exposure Scenarios Addressed by the Analyses using the IEUBK and ALM Models

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Exposure Medium	Exposure Scenario/Receptor Population									
	Tribal Lifeway	Exposure Pathway	IEUBK (initial)	IEUBK (additional)	Aquatic Worker	Exposure Pathway	ALM	General Public	Exposure Pathway	IEUBK (initial)
Sediment	Hunting/fishing/gathering and recreational activities	Incidental Ingestion	√(+,-)[b]	√(++)	Work activities	Incidental Ingestion	√	Recreational activities	Incidental Ingestion	√(+)[b]
		Dermal Contact [a]	(-)			Dermal Contact [a]	(-)		Dermal Contact [a]	(-)
Surface Water	Hunting/fishing/gathering and recreational activities	Incidental Ingestion	√ (-) [c]	√ [c]	Work activities	Incidental Ingestion	(-)	Recreational activities	Incidental Ingestion	√ (-) [c]
		Dermal Contact [a]	(-)			Dermal Contact [a]	(-)		Dermal Contact [a]	(-)
	Potable source	Ingestion	√	√(++)				Potable source	Ingestion	√
		Dermal Contact [a]	(-)					Dermal Contact	Dermal Contact [a]	(-)
	Sweat lodge use	Ingestion	√ (-) [c]	√ [c]						
		Dermal Contact [a]	(-)							
		Inhalation (water vapor)	(-)							
Fish	Food consumption	Ingestion	√(+,-) [d]	√(++) [d]				Fish consumption		√(+,-) [d]
Shellfish	Food consumption	Ingestion	√(+,-) [d]	√(++) [d]						
Aquatic Plant as Food	Food consumption	Ingestion	√(+,-) [d]	√(++) [d]						
Aquatic Plant as Salve	Medicinal use	Dermal Contact [a]	(-)							
Amphibian/Aquatic Reptile	Food consumption	Ingestion	√(+,-) [d]	√(++) [d]						
Semi-Aquatic mammal	Food consumption	Ingestion	√(+,-) [d]	√(++) [d]						

Notes:

[a] IEUBK/ALM does not evaluate lead exposure through dermal contact.

[b] Lead exposure through incidental ingestion of sediment was evaluated based on residential exposure assumptions.

[c] Ingestion of surface water as potable source was assumed to include exposure from other scenarios.

[d] Ingestion of OU5 food items was evaluated as part of regular U.S. diet for the initial analysis. The dietary intake of lead was calculated conservatively based on ingestion rates in Harper (2008), EPA EFH and updates (EPA, 2011, 2018a, 2018b), and site-specific data in the additional analysis (Appendix E Table 5).

√ - The exposure pathway was evaluated in the analysis.

Qualitative evaluation of potential impact on overall risk assessment conclusion:

(++) - Analysis using the RME exposure assumptions likely overestimates potential lead exposure for Tribal Lifeway child.

(+) - Analysis using the IEUBK default input parameter values likely overestimates potential lead exposure occurring during recreational activities.

(+,-) Although analysis using the IEUBK default input parameter values are considered an appropriate representation of potential lead exposure, it may over- or underestimate lead exposure through exposure media within OU5.

(-) - Analysis does not include potential lead exposure through the specific exposure pathway; therefore, it likely underestimates potential lead exposure.

Acronyms:

ALM = Adult Lead Methodology

IEUBK = Integrated Exposure Uptake Biokinetic

References:

EPA. 2011. Exposure Factors Handbook: 2011 Edition. PA/600/R-09/052F. September.

EPA. 2018a. Update for Chapter 9 of the Exposure Factors Handbook. Intake of Fruits and Vegetables. EPA/600/R-18/098F. August.

EPA. 2018b. Update for Chapter 11 of the Exposure Factors Handbook. Intake of Meats, Dairy Products, and Fats. EPA/600/R-17/485F. August.

Harper. 2008. Quapaw Traditional Lifeways Scenario. Prepared by Barbara Harper, PhD, DABT. AESE, Inc.

Appendix E, Table 10. Identification of Lead as a Final COC

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Receptor Scenario	Elm Creek		Tar Creek		Neosho River		Beaver Creek		Lost Creek		Lower Spring River	
	Preliminary COC	Bkgd Comp. Results [a]	Preliminary COC	Bkgd Comp. Results [a]	Preliminary COC	Bkgd Comp. Results [a]	Preliminary COC	Bkgd Comp. Results [a]	Preliminary COC	Bkgd Comp. Results [a]	Preliminary COC	Bkgd Comp. Results [a]
Sediment												
Tribal Lifeway (child) [b]	Lead	Yes (s/us)	Lead	Yes (s/us)	Lead	No (s/us)	Lead	Yes (s/us)	Lead	No (s/us)	Lead	Yes (s/us)
Aquatic Worker	Lead	Yes (s/us)	Lead	Yes (s/us)								
General Public (child) [b]	Lead	Yes (s/us)	Lead	Yes (s/us)			Lead	Yes (s/us)			Lead	Yes (s/us)
Surface Water												
Tribal Lifeway (child) [b]	Lead	Yes	Lead	Yes	Lead	No	Lead	Yes	Lead	No	Lead	No
General Public (child) [b]	Lead	Yes	Lead	Yes			Lead	Yes			Lead	No
Biota												
Tribal Lifeway (child) [b]	Lead	Yes (s/us)	Lead	Yes (s/us)	Lead	No (s/us)	Lead	Yes (s/us)	Lead	No (s/us)	Lead	Yes (s/us)
General Public (child) [b]	Lead	Yes (s/us)	Lead	Yes (s/us)			Lead	Yes (s/us)			Lead	Yes (s/us)

Notes:

[a] Results of background comparisons are presented as follows:

Yes (s/us)	site > bkgd based on both sieved and unsieved data
No (s/us)	no statistical difference between site and bkgd based on both sieved and unsieved data
Yes	site > bkgd; statistically significant increase in site concentrations above bkgd
No	no statistical difference between site and bkgd

[b] Conclusions are based on the results of child receptors using the IEUBK model, which addresses multi-media nature of exposure to lead. Child receptors are more sensitive to lead than adult receptors.

Refinement of lead as the final COC.

To select lead as a final COC, the results of background comparison were reviewed.
When statistical background comparison (central tendency) indicates lead concentrations in site medium are not greater than background, lead was eliminated as a final COC. When the background comparison indicates site > bkgd, lead was identified as a final COC.

Because lead has been identified as a primary contaminant of concern, no further evaluation of lead was performed based on the nature of mine-related contamination.

Lead Final COC

Acronyms:

Bkgd = background

COC = chemical of concern

Attachment A
Memorandum, TRW Lead Committee Consultation: Review of OU5 Tar Creek Superfund Site

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Technical Review Workgroup Lead Committee

An interoffice workgroup convened by Office of Superfund Remediation and Technology Innovation

MEMORANDUM

Date: December 17, 2019

Subject: TRW Lead Committee Consultation: Review of OU5 Tar Creek Superfund Site

From: Michele Burgess, Todd Phillips, and James Brown
Co-Chairpersons of the Technical Review Workgroup Lead Committee

To: Katrina Coltrain, US EPA Region 6
Ghassan Khoury, US EPA Region 6

The Technical Review Workgroup (TRW) Lead Committee prepared this memorandum in response to your request on November 7, 2019 for review of Tar Creek (OU5) Superfund Site in Region 6.

During the teleconference with TRW Lead Committee on November 14, you presented information on the site that informed the following comments.

- While the memo acknowledges that using sediment and surface water Exposure Point Concentrations (EPCs) as soil and drinking water inputs for the risk calculations is an overestimate of exposure, they do not quantify the magnitude of the overestimate. It is recommended that a time-weighted analysis using site-specific or reasonable estimates of exposure to these site media along with appropriate residential media concentrations be included in the Human Health Risk Assessment (HHRA) to inform risk management.
- For Model Run 2, the selected ingestion rate of 400 mg/day for sediment seems very high compared to what is typically used for children (generally 100 mg/day or less). Central tendency estimates are recommended for risk assessment.

MEMBERS OF THE LEAD COMMITTEE

Region 1
Mary Ballew
Courtney Carroll

Region 2
Julie McPherson

Region 3
Dawn Ioven
Linda Watson

Region 4
Kevin Koporec

Region 5
Keith Fusinski
Andrew Podowski

Region 6
Ghassan Khoury

Region 7
Todd Phillips*

Region 8
Charlie Partridge

Region 9
Sophia Serda

Region 10
Marc Stifelman

ORD/NCEA
James Brown*
Kirk Scheckel

Utah DEQ
Scott Everett

OSRTI
Michele Burgess*

ATSDR
Steve Jones

*Chair of the Lead Committee

- For the assessment of tribal lifeways that include intake of alternative media (like plants), one approach would be to calculate the intake (in µg of Pb per day) for each medium or species comprising that medium (e.g., plant type) and to evaluate whether the intake is greater than 1 µg Pb/day. Those below 1 µg Pb/day may be considered to contribute minimally to risk (this is analogous to P5 soil exposures differing by < 20 ppm). Given that all the alternate media intakes exceed 1 µg Pb/day media, those media may be candidates for risk management consideration. Are public health entities developing local food intake recommendations for other biota (e.g., https://www.deq.ok.gov/state-environmental-laboratory-services/environmental-public-health-information/healthy-fish-consumption-in-oklahoma/tar-creek/)?
- Exposure to metal contaminants in river water through sweat lodge use may be a complete pathway; however, the lead (dissolved or suspended in particulates) would not be vaporized (only the water) so the inhalation and dermal exposures to lead during sweat lodge use are likely to be negligible relative to intakes from using that water as a source of drinking water.
- Because some of the exposure inputs (exposure point concentrations and inputs) result in IEUBK model predictions that exceed 30 µg/dL, these suggest that exposure is unacceptable. That the IEUBK model has not been validated for such high exposures is not an issue; the objective of modeling is to determine whether there is unacceptable risk rather than precisely quantifying the level of that risk exceedance.
- Development of PRGs is typically a risk management activity and is generally based on exposure to those exposure media within EPA's authority for this site (commonly soil, sediment, and surface water). For the risk assessment (which generally precedes the development of PRGs), consideration of other media (such as local or home-grown produce or game) may be appropriate as determined by the conceptual site model.

Attachment B
Integrated Exposure Uptake Biokinetic (IEUBK) Output

Appendix E. Attachment B, Table 1. IEUBK Output - Initial Analysis (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Fourmile Creek [Reference]))

Run Mode: Research (Initial Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 1. IEUBK Output - Initial Analysis (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 2.400 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 28.970 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	27.100	28.970
1-2	27.100	28.970
2-3	27.100	28.970
3-4	27.100	28.970
4-5	27.100	28.970
5-6	27.100	28.970
6-7	27.100	28.970

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 1. IEUBK Output - Initial Analysis (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.293	0.000	0.467
1-2	0.057	2.435	0.000	0.500
2-3	0.076	2.535	0.000	0.596
3-4	0.093	2.627	0.000	0.633
4-5	0.102	2.759	0.000	0.669
5-6	0.111	2.961	0.000	0.706
6-7	0.119	2.921	0.000	0.742

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	0.706	2.500	1.4
1-2	0.768	3.760	1.6
2-3	0.550	3.756	1.4
3-4	0.519	3.871	1.4
4-5	0.553	4.084	1.3
5-6	0.430	4.208	1.3
6-7	0.456	4.238	1.2

Appendix E. Attachment B, Table 2. IEUBK Output - Initial Analysis (Elm Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Elm Creek)

Run Mode: Research (Initial Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 2. IEUBK Output - Initial Analysis (Elm Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 63.600 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 3006.700 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	4281.000	3006.700
1-2	4281.000	3006.700
2-3	4281.000	3006.700
3-4	4281.000	3006.700
4-5	4281.000	3006.700
5-6	4281.000	3006.700
6-7	4281.000	3006.700

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 2. IEUBK Output - Initial Analysis (Elm Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	0.694	0.000	6.640
1-2	0.057	1.392	0.000	7.570
2-3	0.076	1.658	0.000	10.324
3-4	0.093	1.814	0.000	11.583
4-5	0.102	1.949	0.000	12.528
5-6	0.111	2.249	0.000	14.211
6-7	0.119	2.233	0.000	15.040

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	48.219	55.588	27.4
1-2	55.889	64.908	26.4
2-3	45.810	57.868	21.4
3-4	45.641	59.132	19.9
4-5	49.736	64.316	20.0
5-6	41.598	58.170	18.1
6-7	44.347	61.739	16.8

Appendix E. Attachment B, Table 3. IEUBK Output - Initial Analysis (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Tar Creek)

Run Mode: Research (Initial Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 3. IEUBK Output - Initial Analysis (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 36.800 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 776.500 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	1095.000	776.500
1-2	1095.000	776.500
2-3	1095.000	776.500
3-4	1095.000	776.500
4-5	1095.000	776.500
5-6	1095.000	776.500
6-7	1095.000	776.500

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 3. IEUBK Output - Initial Analysis (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	0.998	0.000	5.523
1-2	0.057	1.948	0.000	6.129
2-3	0.076	2.150	0.000	7.744
3-4	0.093	2.280	0.000	8.422
4-5	0.102	2.420	0.000	9.002
5-6	0.111	2.668	0.000	9.752
6-7	0.119	2.640	0.000	10.285

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	17.807	24.361	12.6
1-2	20.093	28.227	11.9
2-3	15.257	25.226	9.6
3-4	14.736	25.531	8.8
4-5	15.868	27.393	8.8
5-6	12.675	25.206	8.0
6-7	13.466	26.509	7.4

Appendix E. Attachment B, Table 4. IEUBK Output - Initial Analysis (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Neosho River)

Run Mode: Research (Initial Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 4. IEUBK Output - Initial Analysis (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 4.500 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 36.460 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	37.800	36.460
1-2	37.800	36.460
2-3	37.800	36.460
3-4	37.800	36.460
4-5	37.800	36.460
5-6	37.800	36.460
6-7	37.800	36.460

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 4. IEUBK Output - Initial Analysis (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.284	0.000	0.869
1-2	0.057	2.421	0.000	0.931
2-3	0.076	2.522	0.000	1.111
3-4	0.093	2.615	0.000	1.181
4-5	0.102	2.748	0.000	1.250
5-6	0.111	2.950	0.000	1.319
6-7	0.119	2.911	0.000	1.387

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	0.923	3.111	1.7
1-2	1.006	4.416	1.8
2-3	0.721	4.430	1.7
3-4	0.681	4.570	1.6
4-5	0.726	4.827	1.6
5-6	0.565	4.945	1.5
6-7	0.598	5.015	1.4

Appendix E. Attachment B, Table 5. IEUBK Output - Initial Analysis (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Beaver Creek)

Run Mode: Research (Initial Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 5. IEUBK Output - Initial Analysis (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 10.600 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 202.500 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	275.000	202.500
1-2	275.000	202.500
2-3	275.000	202.500
3-4	275.000	202.500
4-5	275.000	202.500
5-6	275.000	202.500
6-7	275.000	202.500

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 5. IEUBK Output - Initial Analysis (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.205	0.000	1.920
1-2	0.057	2.294	0.000	2.079
2-3	0.076	2.429	0.000	2.521
3-4	0.093	2.534	0.000	2.696
4-5	0.102	2.669	0.000	2.860
5-6	0.111	2.885	0.000	3.038
6-7	0.119	2.848	0.000	3.197

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	5.495	8.654	4.7
1-2	6.048	10.478	4.5
2-3	4.407	9.433	3.6
3-4	4.185	9.507	3.3
4-5	4.474	10.105	3.3
5-6	3.504	9.537	3.0
6-7	3.714	9.878	2.8

Appendix E. Attachment B, Table 6. IEUBK Output - Initial Analysis (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Lost Creek)

Run Mode: Research (Initial Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 6. IEUBK Output - Initial Analysis (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 2.700 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 127.600 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	168.000	127.600
1-2	168.000	127.600
2-3	168.000	127.600
3-4	168.000	127.600
4-5	168.000	127.600
5-6	168.000	127.600
6-7	168.000	127.600

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 6. IEUBK Output - Initial Analysis (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.252	0.000	0.508
1-2	0.057	2.370	0.000	0.547
2-3	0.076	2.492	0.000	0.659
3-4	0.093	2.591	0.000	0.702
4-5	0.102	2.725	0.000	0.743
5-6	0.111	2.935	0.000	0.787
6-7	0.119	2.896	0.000	0.828

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	3.541	5.335	2.9
1-2	3.874	6.847	2.9
2-3	2.804	6.030	2.3
3-4	2.653	6.039	2.1
4-5	2.831	6.402	2.1
5-6	2.210	6.042	1.9
6-7	2.341	6.184	1.8

Appendix E. Attachment B, Table 7. IEUBK Output - Initial Analysis (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Lower Spring River)

Run Mode: Research (Initial Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 7. IEUBK Output - Initial Analysis (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 6.200 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 112.200 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	146.000	112.200
1-2	146.000	112.200
2-3	146.000	112.200
3-4	146.000	112.200
4-5	146.000	112.200
5-6	146.000	112.200
6-7	146.000	112.200

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 7. IEUBK Output - Initial Analysis (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.249	0.000	1.165
1-2	0.057	2.365	0.000	1.254
2-3	0.076	2.484	0.000	1.507
3-4	0.093	2.581	0.000	1.606
4-5	0.102	2.716	0.000	1.702
5-6	0.111	2.924	0.000	1.801
6-7	0.119	2.886	0.000	1.895

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	3.088	5.535	3.0
1-2	3.379	7.055	3.0
2-3	2.441	6.508	2.5
3-4	2.311	6.592	2.3
4-5	2.466	6.986	2.3
5-6	1.925	6.761	2.1
6-7	2.039	6.939	2.0

Appendix E. Attachment B, Table 8. IEUBK Output - Additional Analysis (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: January 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Fourmile Creek [Reference]))

Run Mode: Research (Additional Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	3582.000
2-3	3879.000
3-4	4657.000
4-5	4657.000
5-6	4658.000
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 8. IEUBK Output - Additional Analysis (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.780
1-2	0.780
2-3	0.780
3-4	0.780
4-5	0.780
5-6	0.780
6-7	0.780

Drinking Water Concentration: 2.400 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 28.970 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	27.100	28.970
1-2	27.100	28.970
2-3	27.100	28.970
3-4	27.100	28.970
4-5	27.100	28.970
5-6	27.100	28.970
6-7	27.100	28.970

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 8. IEUBK Output - Additional Analysis (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.252	0.000	0.881
1-2	0.057	428.686	0.000	0.224
2-3	0.076	470.413	0.000	0.227
3-4	0.093	562.413	0.000	0.226
4-5	0.102	576.743	0.000	0.232
5-6	0.111	589.911	0.000	0.237
6-7	0.119	2.883	0.000	0.907

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	3.177	5.344	2.9
1-2	0.808	429.775	111.1
2-3	0.819	471.535	124.4
3-4	0.815	563.547	133.1
4-5	0.836	577.913	133.4
5-6	0.855	591.114	129.6
6-7	3.271	7.180	56.7

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Table 9. IEUBK Output - Additional Analysis (Elm Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Elm Creek)

Run Mode: Research (Additional Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	3582.000
2-3	3879.000
3-4	4657.000
4-5	4657.000
5-6	4658.000
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 9. IEUBK Output - Additional Analysis (Elm Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.780
1-2	0.780
2-3	0.780
3-4	0.780
4-5	0.780
5-6	0.780
6-7	0.780

Drinking Water Concentration: 36.800 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 3006.700 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	4281.000	3006.700
1-2	4281.000	3006.700
2-3	4281.000	3006.700
3-4	4281.000	3006.700
4-5	4281.000	3006.700
5-6	4281.000	3006.700
6-7	4281.000	3006.700

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 9. IEUBK Output - Additional Analysis (Elm Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	0.690	0.000	7.450
1-2	0.057	415.375	0.000	3.329
2-3	0.076	455.861	0.000	3.373
3-4	0.093	547.753	0.000	3.376
4-5	0.102	560.027	0.000	3.452
5-6	0.111	571.349	0.000	3.521
6-7	0.119	2.270	0.000	10.949

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	47.950	56.125	27.7
1-2	99.638	518.399	129.8
2-3	100.977	560.287	140.5
3-4	101.062	652.284	147.6
4-5	103.327	666.908	147.2
5-6	105.393	680.374	143.0
6-7	45.064	58.401	70.4

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Table 10. IEUBK Output - Additional Analysis (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Tar Creek)

Run Mode: Research (Additional Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	3582.000
2-3	3879.000
3-4	4657.000
4-5	4657.000
5-6	4658.000
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 10. IEUBK Output - Additional Analysis (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.780
1-2	0.780
2-3	0.780
3-4	0.780
4-5	0.780
5-6	0.780
6-7	0.780

Drinking Water Concentration: 36.800 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 776.500 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	1095.000	776.500
1-2	1095.000	776.500
2-3	1095.000	776.500
3-4	1095.000	776.500
4-5	1095.000	776.500
5-6	1095.000	776.500
6-7	1095.000	776.500

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 10. IEUBK Output - Additional Analysis (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	0.952	0.000	10.272
1-2	0.057	424.461	0.000	3.401
2-3	0.076	465.842	0.000	3.447
3-4	0.093	557.901	0.000	3.439
4-5	0.102	571.602	0.000	3.523
5-6	0.111	584.208	0.000	3.600
6-7	0.119	2.613	0.000	12.607

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	16.986	28.244	14.6
1-2	26.159	454.079	117.0
2-3	26.512	495.876	129.0
3-4	26.446	587.879	137.2
4-5	27.096	602.324	137.3
5-6	27.688	615.607	133.4
6-7	13.331	28.670	61.6

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Table 11. IEUBK Output - Additional Analysis (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: January 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Neosho River)

Run Mode: Research (Additional Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	3582.000
2-3	3879.000
3-4	4657.000
4-5	4657.000
5-6	4658.000
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 11. IEUBK Output - Additional Analysis (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.780
1-2	0.780
2-3	0.780
3-4	0.780
4-5	0.780
5-6	0.780
6-7	0.780

Drinking Water Concentration: 4.500 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 36.460 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	37.800	36.460
1-2	37.800	36.460
2-3	37.800	36.460
3-4	37.800	36.460
4-5	37.800	36.460
5-6	37.800	36.460
6-7	37.800	36.460

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 11. IEUBK Output - Additional Analysis (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.228	0.000	1.621
1-2	0.057	428.616	0.000	0.420
2-3	0.076	470.337	0.000	0.426
3-4	0.093	562.339	0.000	0.424
4-5	0.102	576.658	0.000	0.435
5-6	0.111	589.818	0.000	0.444
6-7	0.119	2.860	0.000	1.687

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	4.108	6.991	3.8
1-2	1.064	430.157	111.3
2-3	1.079	471.917	124.4
3-4	1.074	563.929	133.1
4-5	1.101	578.297	133.5
5-6	1.126	591.499	129.6
6-7	4.276	8.942	57.0

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Table 12. IEUBK Output - Additional Analysis (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

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Model Version: 1.1 Build11
User Name: Jacobs
Date: January 2020
Site Name: Tar Creek Superfund Site
Operable Unit: OU5 (Beaver Creek)
Run Mode: Research (Additional Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	3582.000
2-3	3879.000
3-4	4657.000
4-5	4657.000
5-6	4658.000
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 12. IEUBK Output - Additional Analysis (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.780
1-2	0.780
2-3	0.780
3-4	0.780
4-5	0.780
5-6	0.780
6-7	0.780

Drinking Water Concentration: 10.600 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 202.500 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	275.000	202.500
1-2	275.000	202.500
2-3	275.000	202.500
3-4	275.000	202.500
4-5	275.000	202.500
5-6	275.000	202.500
6-7	275.000	202.500

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 12. IEUBK Output - Additional Analysis (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	0.989	0.000	3.075
1-2	0.057	427.655	0.000	0.987
2-3	0.076	469.302	0.000	1.000
3-4	0.093	561.323	0.000	0.997
4-5	0.102	575.502	0.000	1.022
5-6	0.111	588.535	0.000	1.045
6-7	0.119	2.587	0.000	3.595

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	20.986	25.084	13.0
1-2	6.737	435.436	113.4
2-3	6.827	477.205	125.5
3-4	6.802	569.214	134.0
4-5	6.973	583.600	134.3
5-6	7.130	596.820	130.5
6-7	24.535	30.835	60.4

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Table 13. IEUBK Output - Additional Analysis (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: January 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Lost Creek)

Run Mode: Research (Additional Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	3582.000
2-3	3879.000
3-4	4657.000
4-5	4657.000
5-6	4658.000
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 13. IEUBK Output - Additional Analysis (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.780
1-2	0.780
2-3	0.780
3-4	0.780
4-5	0.780
5-6	0.780
6-7	0.780

Drinking Water Concentration: 2.700 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 127.600 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	168.000	127.600
1-2	168.000	127.600
2-3	168.000	127.600
3-4	168.000	127.600
4-5	168.000	127.600
5-6	168.000	127.600
6-7	168.000	127.600

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 13. IEUBK Output - Additional Analysis (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.098	0.000	0.870
1-2	0.057	428.159	0.000	0.252
2-3	0.076	469.845	0.000	0.255
3-4	0.093	561.857	0.000	0.254
4-5	0.102	576.109	0.000	0.261
5-6	0.111	589.209	0.000	0.266
6-7	0.119	2.722	0.000	0.964

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	14.446	16.448	8.7
1-2	4.182	432.650	112.4
2-3	4.238	474.414	124.9
3-4	4.221	566.425	133.6
4-5	4.328	580.801	133.9
5-6	4.426	594.012	130.0
6-7	16.009	19.813	58.7

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Table 14. IEUBK Output - Additional Analysis (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: January 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Lower Spring River)

Run Mode: Research (Additional Analysis)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	3582.000
2-3	3879.000
3-4	4657.000
4-5	4657.000
5-6	4658.000
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 14. IEUBK Output - Additional Analysis (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.780
1-2	0.780
2-3	0.780
3-4	0.780
4-5	0.780
5-6	0.780
6-7	0.780

Drinking Water Concentration: 6.200 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 112.200 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	146.000	112.200
1-2	146.000	112.200
2-3	146.000	112.200
3-4	146.000	112.200
4-5	146.000	112.200
5-6	146.000	112.200
6-7	146.000	112.200

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 14. IEUBK Output - Additional Analysis (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.106	0.000	2.011
1-2	0.057	428.190	0.000	0.578
2-3	0.076	469.879	0.000	0.586
3-4	0.093	561.889	0.000	0.583
4-5	0.102	576.147	0.000	0.598
5-6	0.111	589.250	0.000	0.612
6-7	0.119	2.731	0.000	2.220

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	12.714	15.865	8.4
1-2	3.655	432.480	112.3
2-3	3.704	474.244	124.9
3-4	3.689	566.255	133.5
4-5	3.783	580.630	133.9
5-6	3.868	593.841	130.0
6-7	14.037	19.107	58.6

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Table 15. IEUBK Output - Targeted Sediment Concentration (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Fourmile Creek [Reference]))

Run Mode: Research (Identification of Target Sediment Concentration)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 15. IEUBK Output - Targeted Sediment Concentration (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 2.400 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 133.200 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	176.000	133.200
1-2	176.000	133.200
2-3	176.000	133.200
3-4	176.000	133.200
4-5	176.000	133.200
5-6	176.000	133.200
6-7	176.000	133.200

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 15. IEUBK Output - Targeted Sediment Concentration (Fourmile Creek [Reference])

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.251	0.000	0.451
1-2	0.057	2.367	0.000	0.486
2-3	0.076	2.491	0.000	0.585
3-4	0.093	2.590	0.000	0.624
4-5	0.102	2.724	0.000	0.661
5-6	0.111	2.934	0.000	0.700
6-7	0.119	2.896	0.000	0.736

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	3.699	5.435	3.0
1-2	4.047	6.957	3.0
2-3	2.931	6.083	2.4
3-4	2.774	6.081	2.1
4-5	2.960	6.447	2.1
5-6	2.311	6.056	1.9
6-7	2.449	6.199	1.8

Appendix E. Attachment B, Table 16. IEUBK Output - Targeted Sediment Concentration (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Neosho River)

Run Mode: Research (Identification of Target Sediment Concentration)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 16. IEUBK Output - Targeted Sediment Concentration (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 4.500 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 112.200 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	146.000	112.200
1-2	146.000	112.200
2-3	146.000	112.200
3-4	146.000	112.200
4-5	146.000	112.200
5-6	146.000	112.200
6-7	146.000	112.200

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 16. IEUBK Output - Targeted Sediment Concentration (Neosho River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.254	0.000	0.848
1-2	0.057	2.372	0.000	0.913
2-3	0.076	2.491	0.000	1.097
3-4	0.093	2.588	0.000	1.169
4-5	0.102	2.723	0.000	1.238
5-6	0.111	2.931	0.000	1.310
6-7	0.119	2.893	0.000	1.378

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	3.098	5.234	2.8
1-2	3.389	6.731	2.9
2-3	2.449	6.112	2.4
3-4	2.317	6.167	2.2
4-5	2.472	6.536	2.1
5-6	1.929	6.281	2.0
6-7	2.044	6.434	1.8

Appendix E. Attachment B, Table 17. IEUBK Output - Targeted Sediment Concentration (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Beaver Creek)

Run Mode: Research (Identification of Target Sediment Concentration)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 17. IEUBK Output - Targeted Sediment Concentration (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 10.600 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 51.300 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	59.000	51.300
1-2	59.000	51.300
2-3	59.000	51.300
3-4	59.000	51.300
4-5	59.000	51.300
5-6	59.000	51.300
6-7	59.000	51.300

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 17. IEUBK Output - Targeted Sediment Concentration (Beaver Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.262	0.000	2.012
1-2	0.057	2.386	0.000	2.162
2-3	0.076	2.489	0.000	2.583
3-4	0.093	2.584	0.000	2.750
4-5	0.102	2.719	0.000	2.912
5-6	0.111	2.922	0.000	3.077
6-7	0.119	2.884	0.000	3.237

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	1.341	4.648	2.5
1-2	1.465	6.071	2.6
2-3	1.052	6.200	2.3
3-4	0.994	6.421	2.2
4-5	1.061	6.795	2.2
5-6	0.827	6.936	2.1
6-7	0.876	7.115	2.0

Appendix E. Attachment B, Table 18. IEUBK Output - Targeted Sediment Concentration (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Lost Creek)

Run Mode: Research (Identification of Target Sediment Concentration)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 18. IEUBK Output - Targeted Sediment Concentration (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 2.700 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 131.100 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	173.000	131.100
1-2	173.000	131.100
2-3	173.000	131.100
3-4	173.000	131.100
4-5	173.000	131.100
5-6	173.000	131.100
6-7	173.000	131.100

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 18. IEUBK Output - Targeted Sediment Concentration (Lost Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.251	0.000	0.508
1-2	0.057	2.368	0.000	0.546
2-3	0.076	2.491	0.000	0.658
3-4	0.093	2.589	0.000	0.702
4-5	0.102	2.723	0.000	0.743
5-6	0.111	2.934	0.000	0.787
6-7	0.119	2.895	0.000	0.828

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	3.638	5.431	3.0
1-2	3.981	6.952	3.0
2-3	2.882	6.107	2.4
3-4	2.728	6.112	2.2
4-5	2.911	6.480	2.1
5-6	2.272	6.104	1.9
6-7	2.408	6.249	1.8

Appendix E. Attachment B, Table 19. IEUBK Output - Targeted Sediment Concentration (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11

User Name: Jacobs

Date: May 2020

Site Name: Tar Creek Superfund Site

Operable Unit: OU5 (Lower Spring River)

Run Mode: Research (Identification of Target Sediment Concentration)

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	3.220	32.000	0.100
1-2	2.000	4.970	32.000	0.100
2-3	3.000	6.090	32.000	0.100
3-4	4.000	6.950	32.000	0.100
4-5	4.000	7.680	32.000	0.100
5-6	4.000	8.320	32.000	0.100
6-7	4.000	8.890	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.660
1-2	5.030
2-3	5.210
3-4	5.380
4-5	5.640
5-6	6.040
6-7	5.950

****** Drinking Water ******

Water Consumption:

Appendix E. Attachment B, Table 19. IEUBK Output - Targeted Sediment Concentration (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

Age	Water (L/day)
.5-1	0.400
1-2	0.430
2-3	0.510
3-4	0.540
4-5	0.570
5-6	0.600
6-7	0.630

Drinking Water Concentration: 6.200 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used

Average multiple source concentration: 96.100 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700

Outdoor airborne lead to indoor household dust lead concentration: 100.000

Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	123.000	96.100
1-2	123.000	96.100
2-3	123.000	96.100
3-4	123.000	96.100
4-5	123.000	96.100
5-6	123.000	96.100
6-7	123.000	96.100

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000

Appendix E. Attachment B, Table 19. IEUBK Output - Targeted Sediment Concentration (Lower Spring River)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

LEAD MODEL FOR WINDOWS Version 1.1

==========

5-6 0.000

6-7 0.000

****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

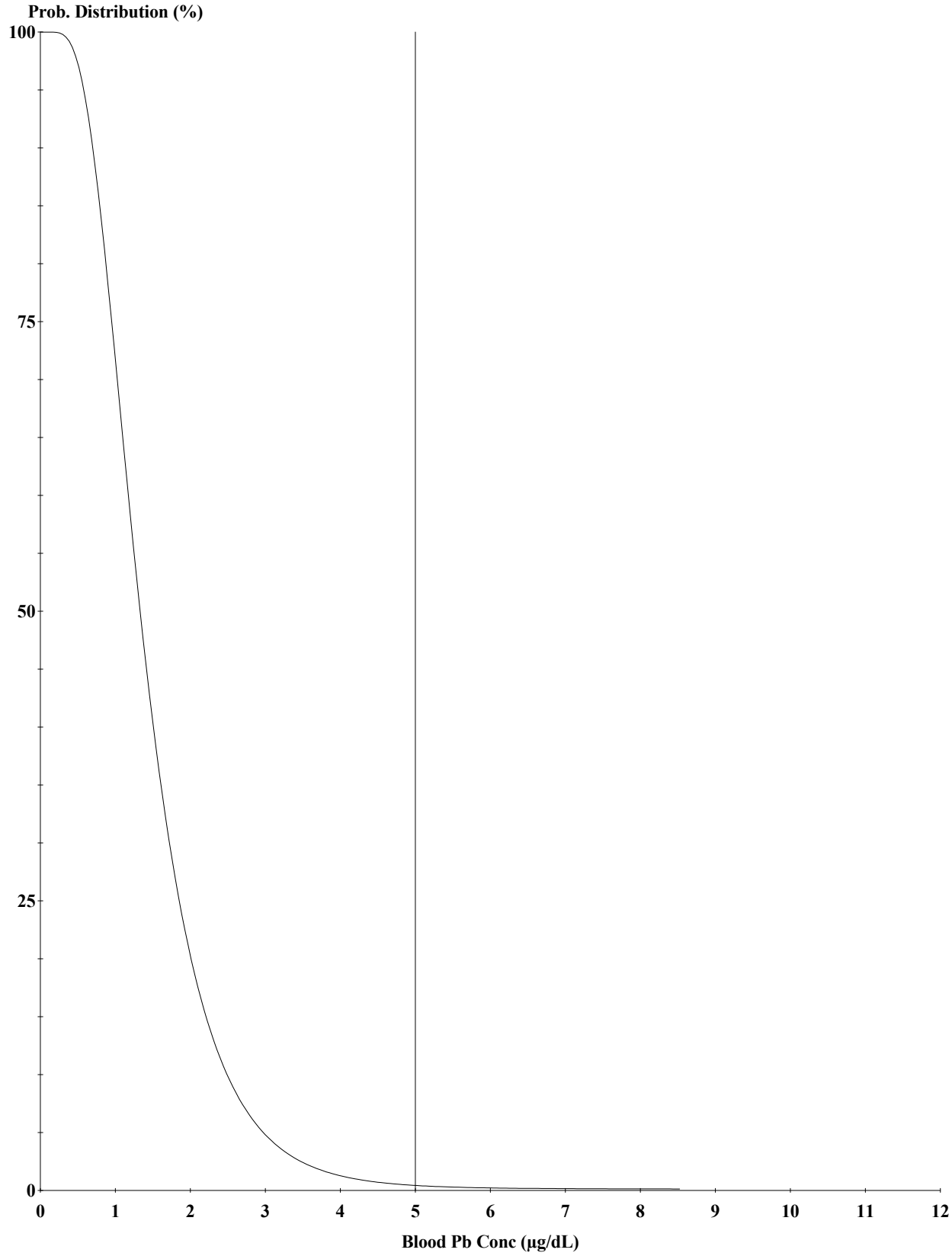
****

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.034	1.256	0.000	1.171
1-2	0.057	2.376	0.000	1.259
2-3	0.076	2.490	0.000	1.511
3-4	0.093	2.587	0.000	1.610
4-5	0.102	2.721	0.000	1.705
5-6	0.111	2.928	0.000	1.803
6-7	0.119	2.890	0.000	1.897

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	2.635	5.096	2.8
1-2	2.882	6.574	2.8
2-3	2.079	6.156	2.4
3-4	1.967	6.256	2.2
4-5	2.099	6.627	2.2
5-6	1.637	6.479	2.0
6-7	1.734	6.640	1.9

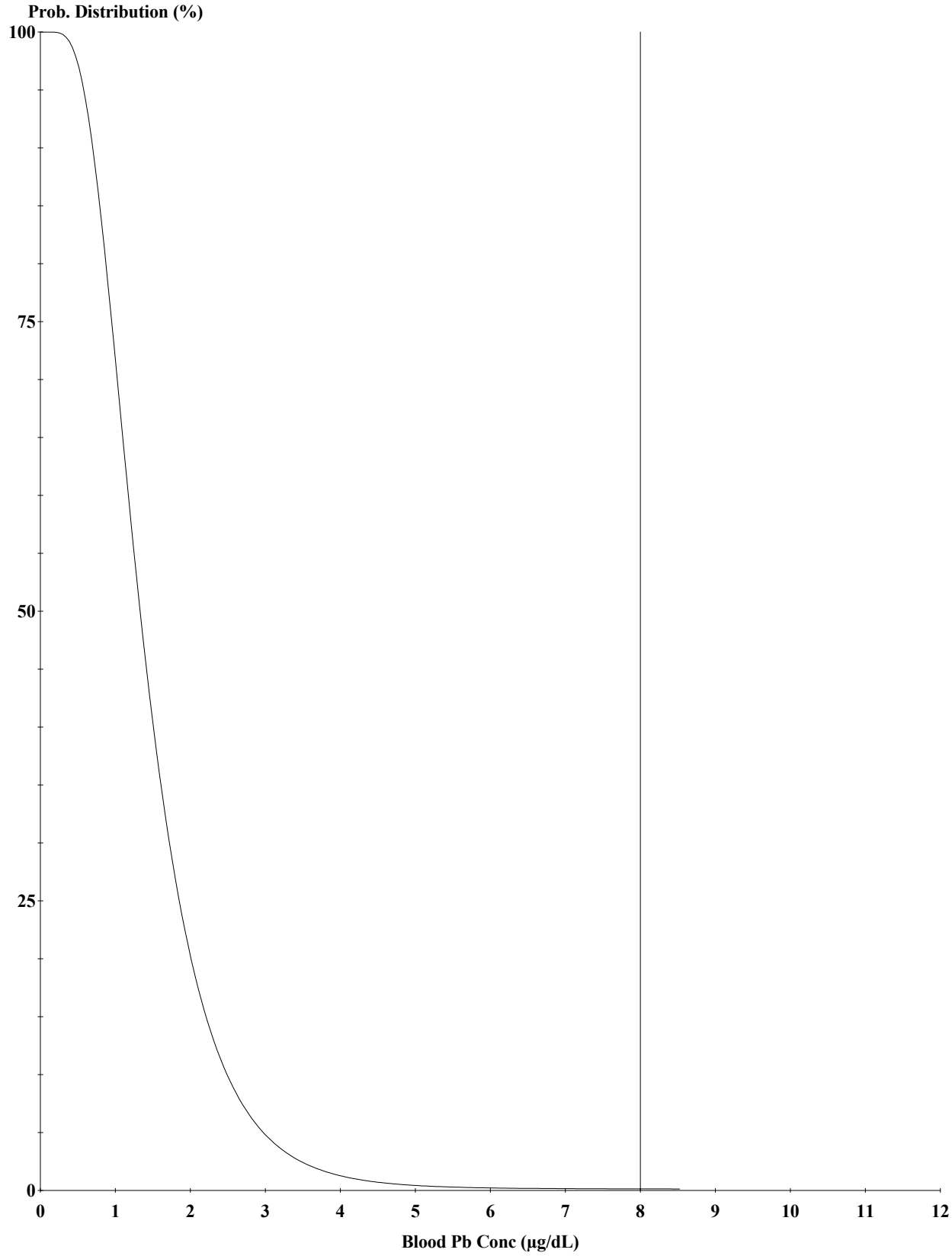


Cutoff = 5.000 µg/dl
Geo Mean = 1.394
GSD = 1.600
% Above = 0.329

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 1. IEUBK Output - Initial Analysis (Fourmile Creek [Reference Site]) 5 µg/dl

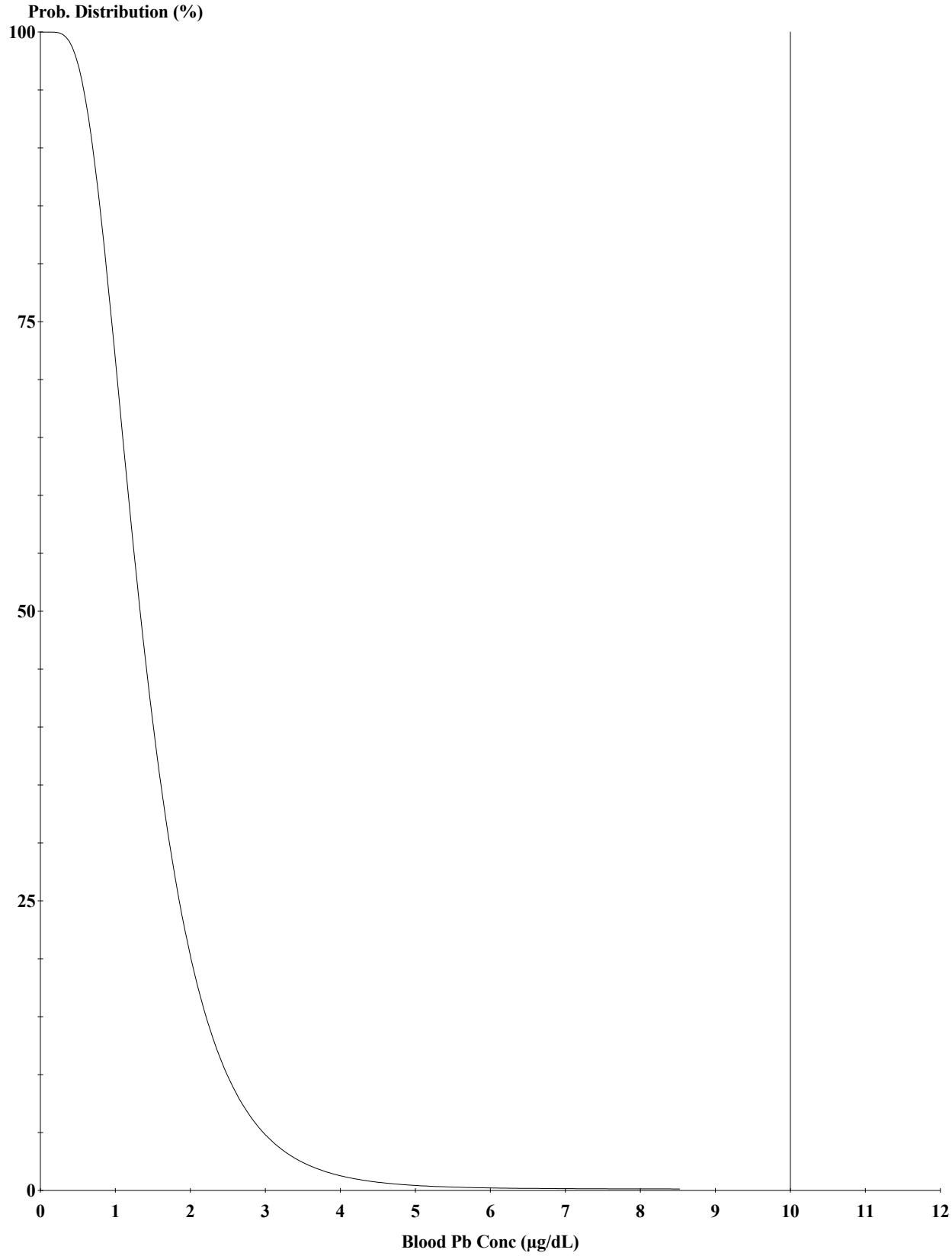


Cutoff = 8.000 µg/dl
Geo Mean = 1.394
GSD = 1.600
% Above = 0.010

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 2. IEUBK Output - Initial Analysis (Fourmile Creek [Reference Site]) 8 µg/dl

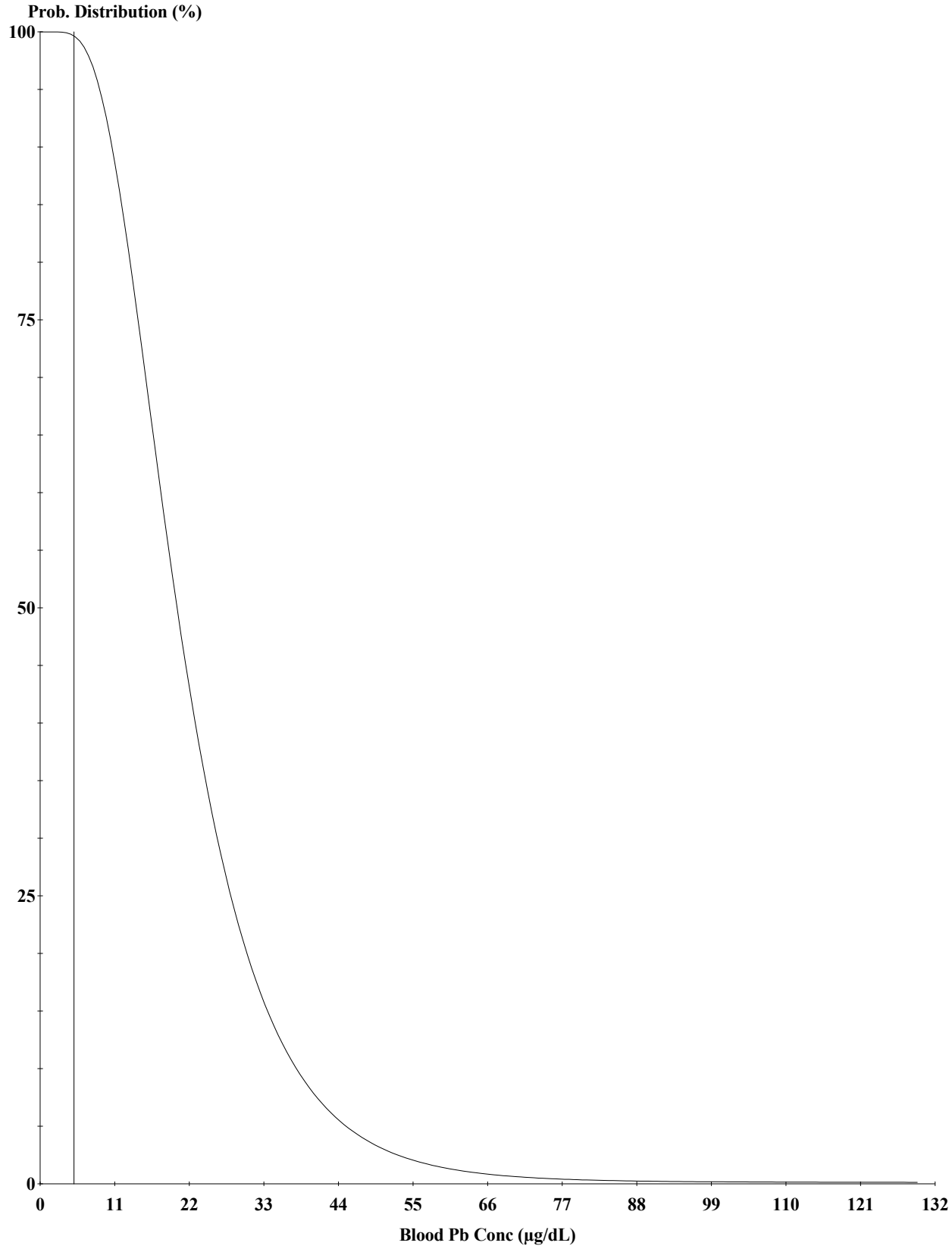


Cutoff = 10.000 µg/dl
Geo Mean = 1.394
GSD = 1.600
% Above = 0.001

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 3. IEUBK Output - Initial Analysis (Fourmile Creek [Reference Site]) 10 µg/dl

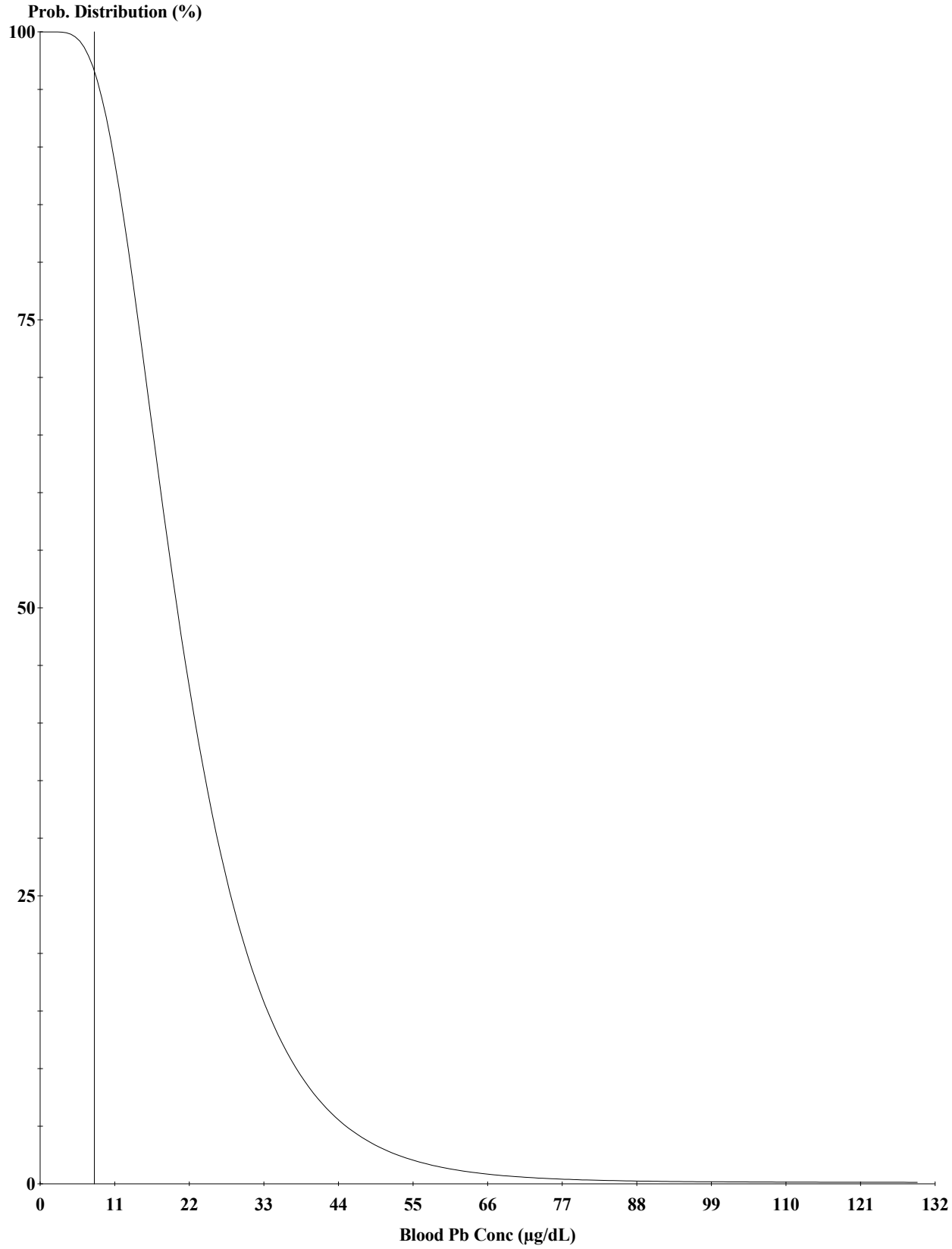


Cutoff = 5.000 µg/dl
Geo Mean = 21.165
GSD = 1.600
% Above = 99.893

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 4. IEUBK Output - Initial Analysis (Elm Creek) 5 µg/dl

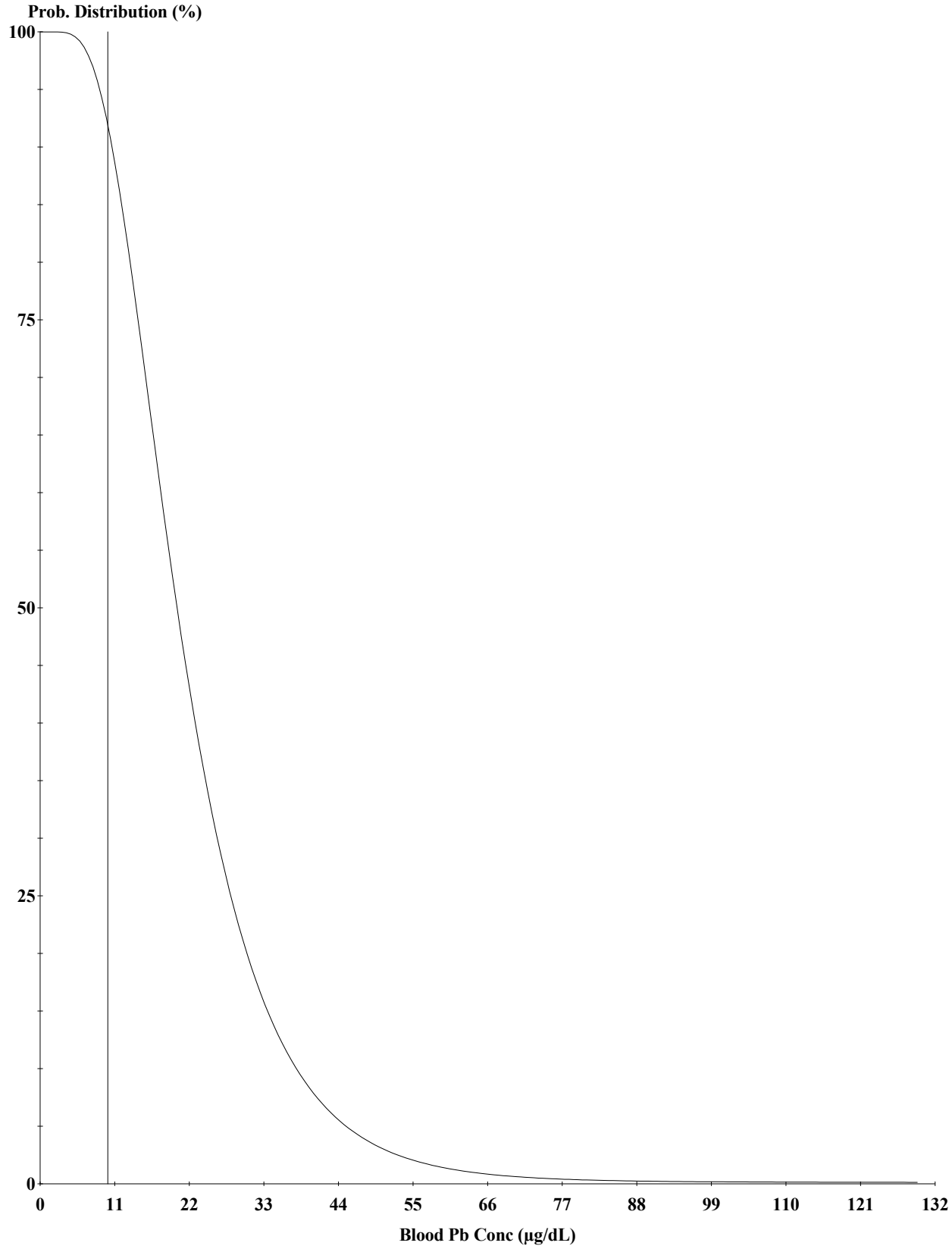


Cutoff = 8.000 µg/dl
Geo Mean = 21.165
GSD = 1.600
% Above = 98.077

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 5. IEUBK Output - Initial Analysis (Elm Creek) 8 µg/dl

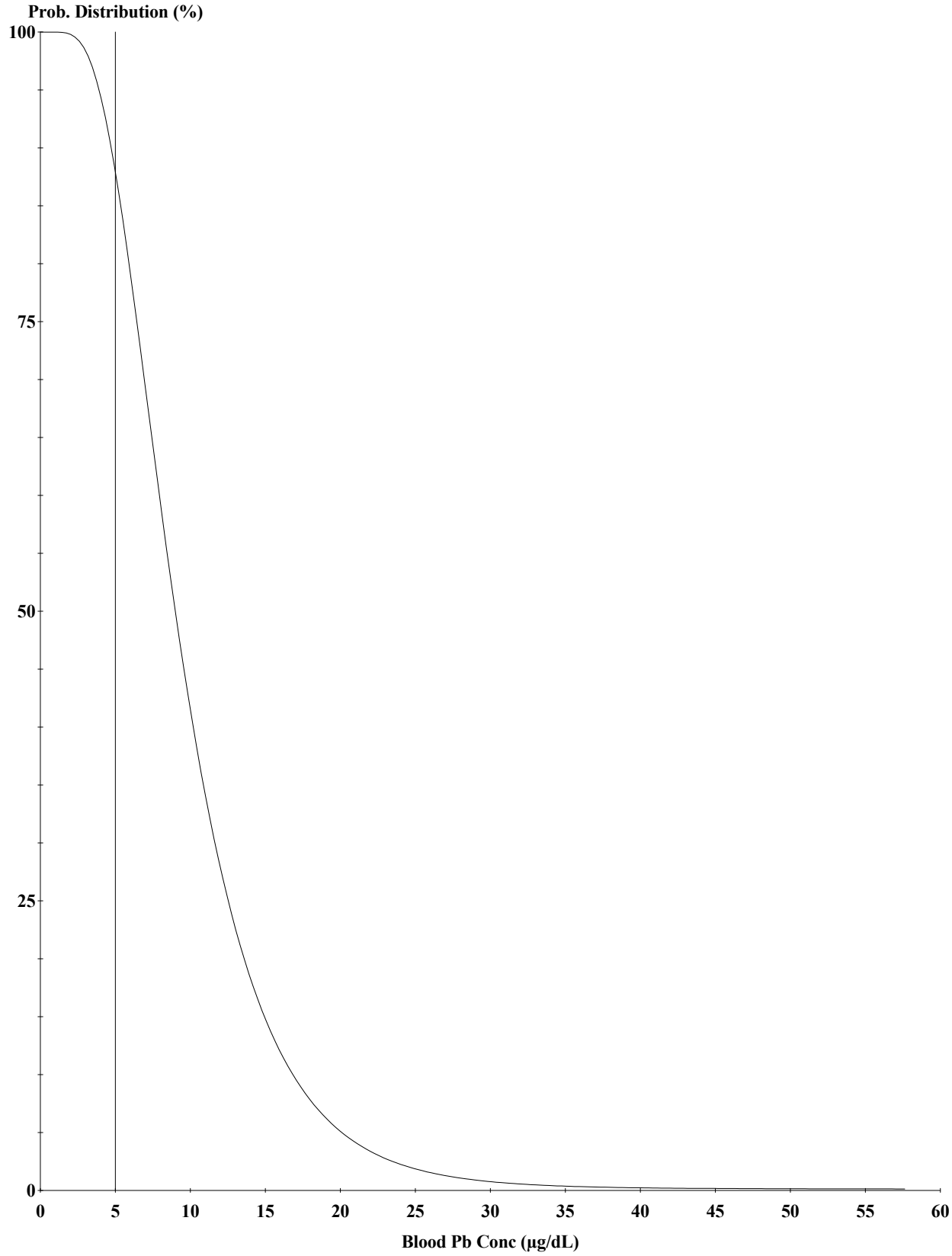


Cutoff = 10.000 µg/dl
Geo Mean = 21.165
GSD = 1.600
% Above = 94.467

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 6. IEUBK Output - Initial Analysis (Elm Creek) 10 µg/dl

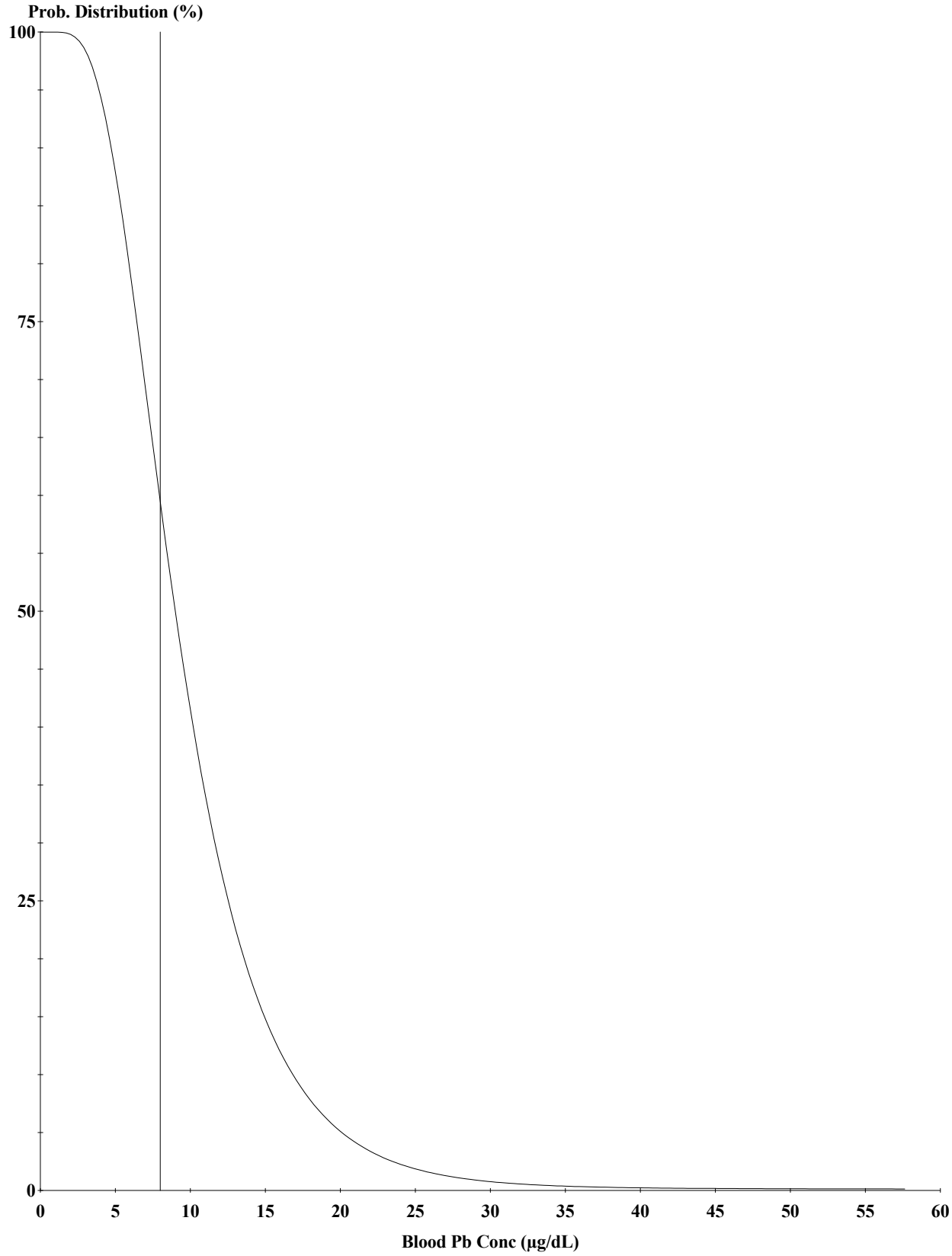


Cutoff = 5.000 µg/dl
Geo Mean = 9.427
GSD = 1.600
% Above = 91.137

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 7. IEUBK Output - Initial Analysis (Tar Creek) 5 µg/dl

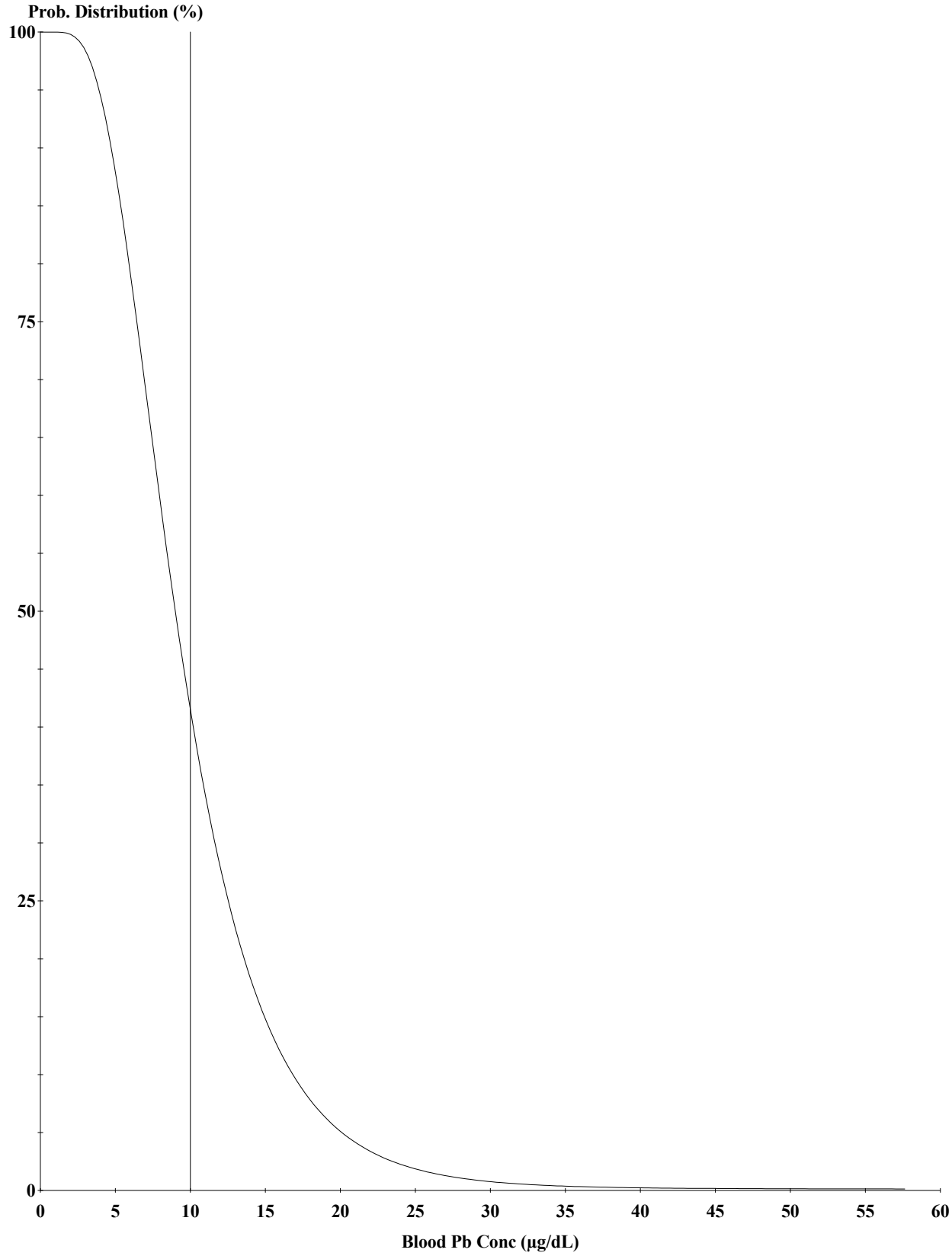


Cutoff = 8.000 µg/dl
Geo Mean = 9.427
GSD = 1.600
% Above = 63.655

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 8. IEUBK Output - Initial Analysis (Tar Creek) 8 µg/dl

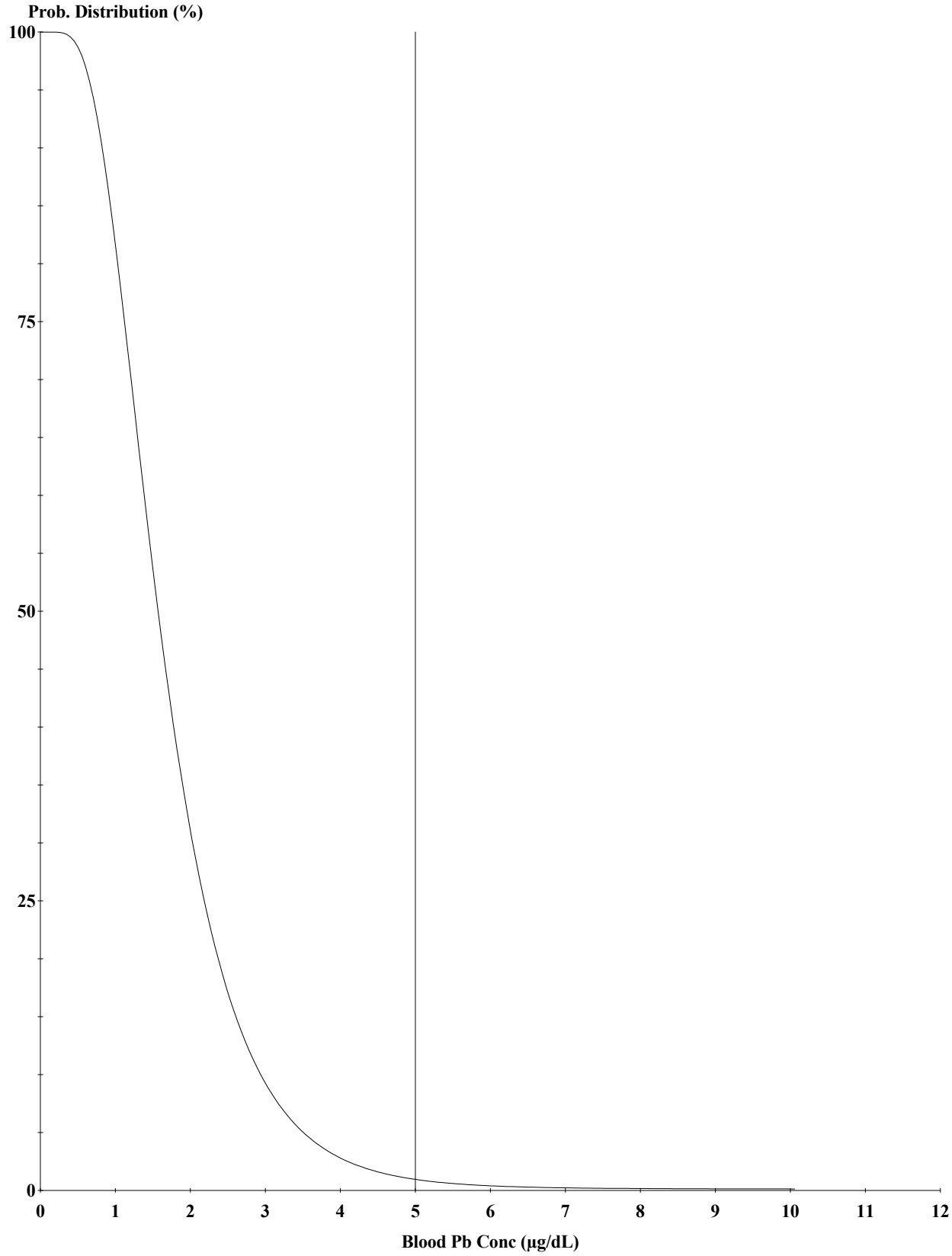


Cutoff = 10.000 µg/dl
Geo Mean = 9.427
GSD = 1.600
% Above = 45.005

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 9. IEUBK Output - Initial Analysis (Tar Creek) 10 µg/dl

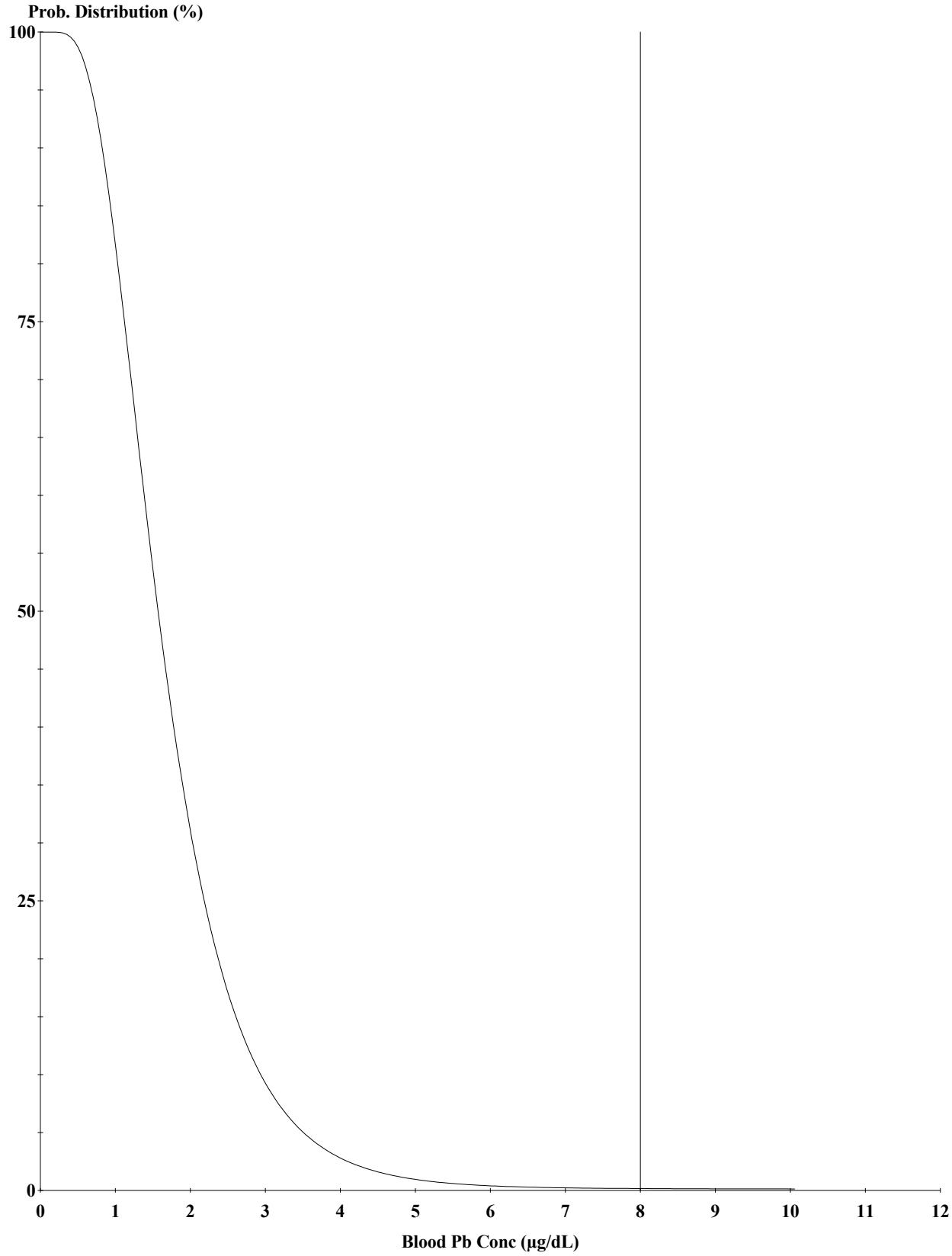


Cutoff = 5.000 µg/dl
Geo Mean = 1.645
GSD = 1.600
% Above = 0.901

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 10. IEUBK Output - Initial Analysis (Neosho River) 5 µg/dl

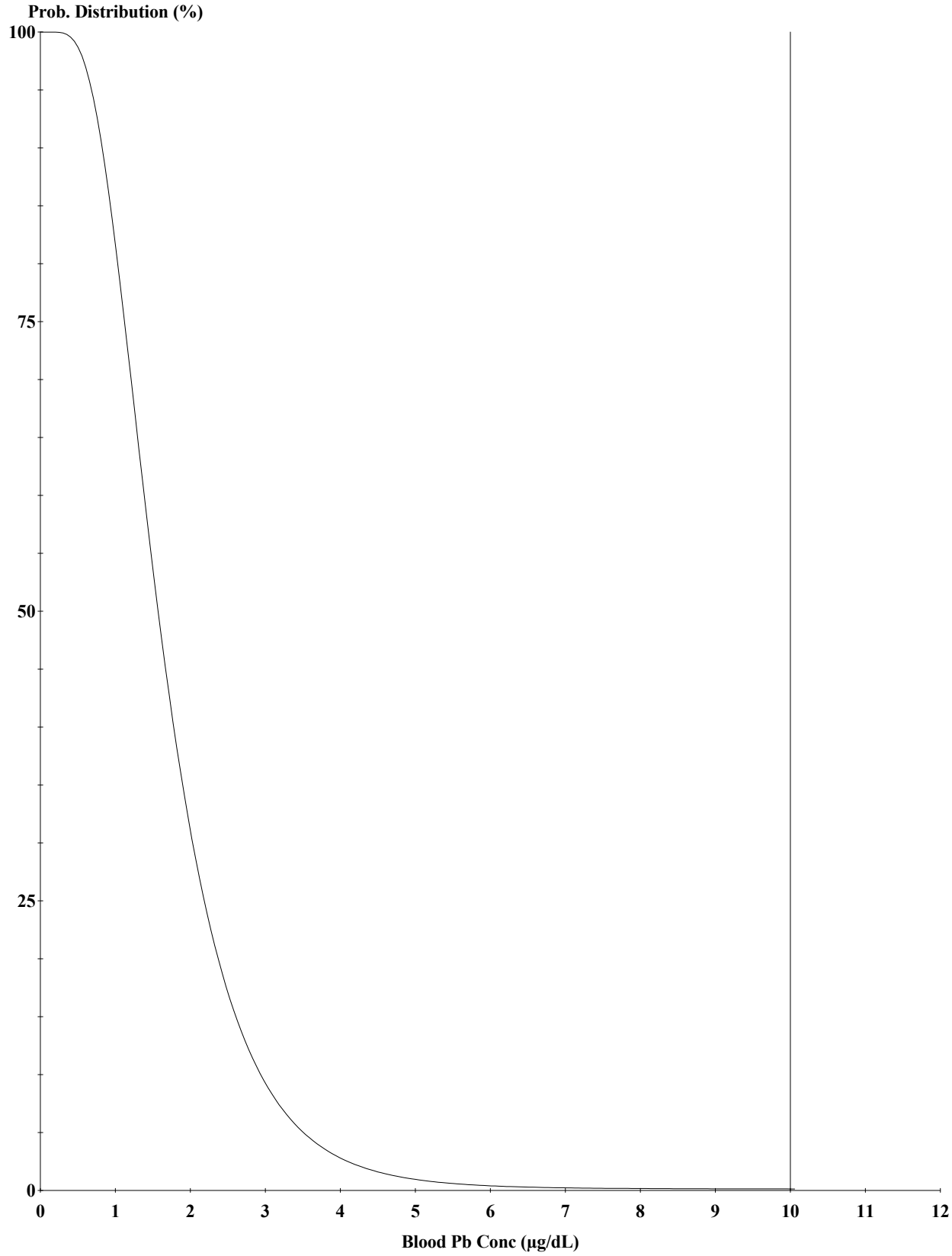


Cutoff = 8.000 µg/dl
Geo Mean = 1.645
GSD = 1.600
% Above = 0.038

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 11. IEUBK Output - Initial Analysis (Neosho River) 8 µg/dl

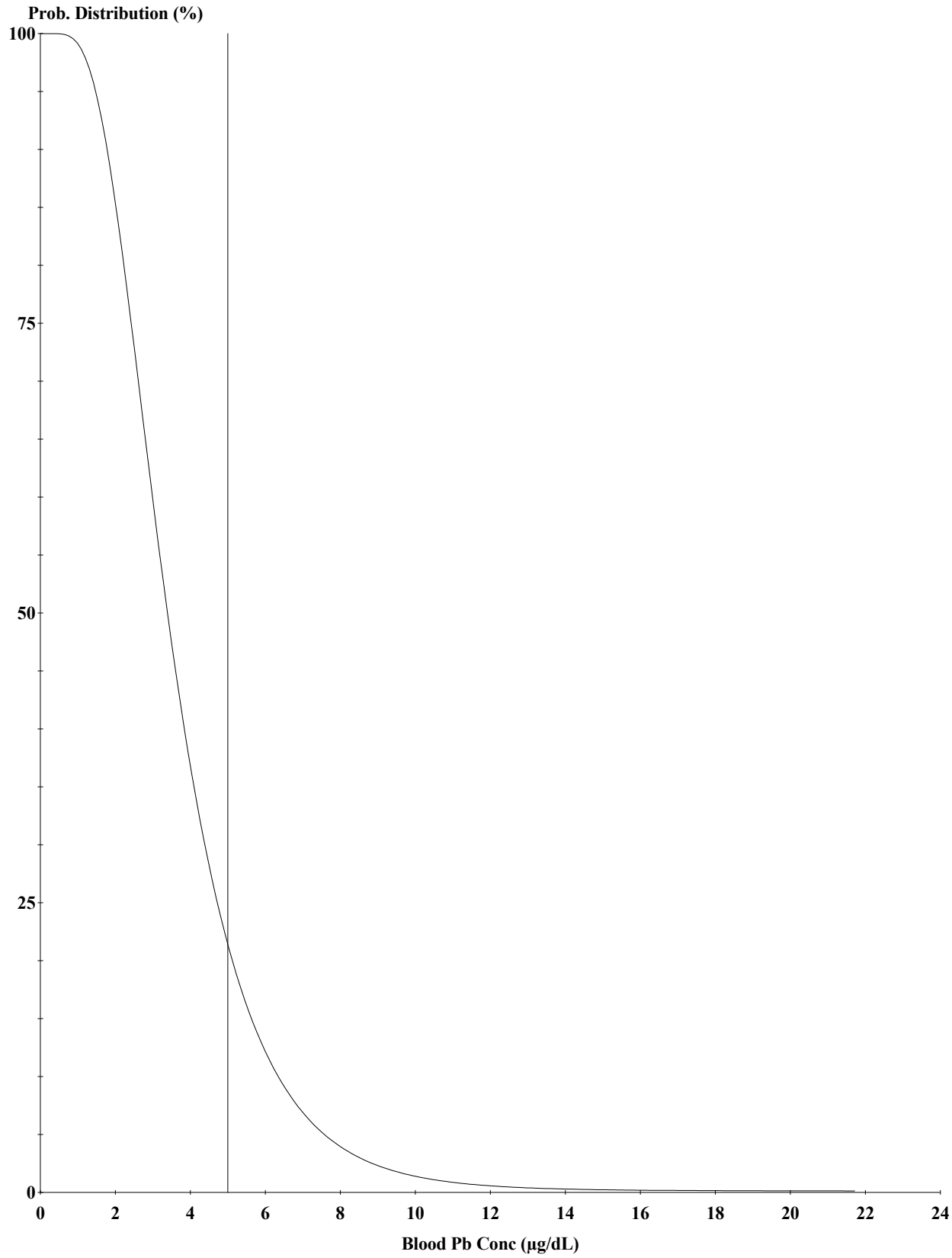


Cutoff = 10.000 µg/dl
Geo Mean = 1.645
GSD = 1.600
% Above = 0.006

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 12. IEUBK Output - Initial Analysis (Neosho River) 10 µg/dl

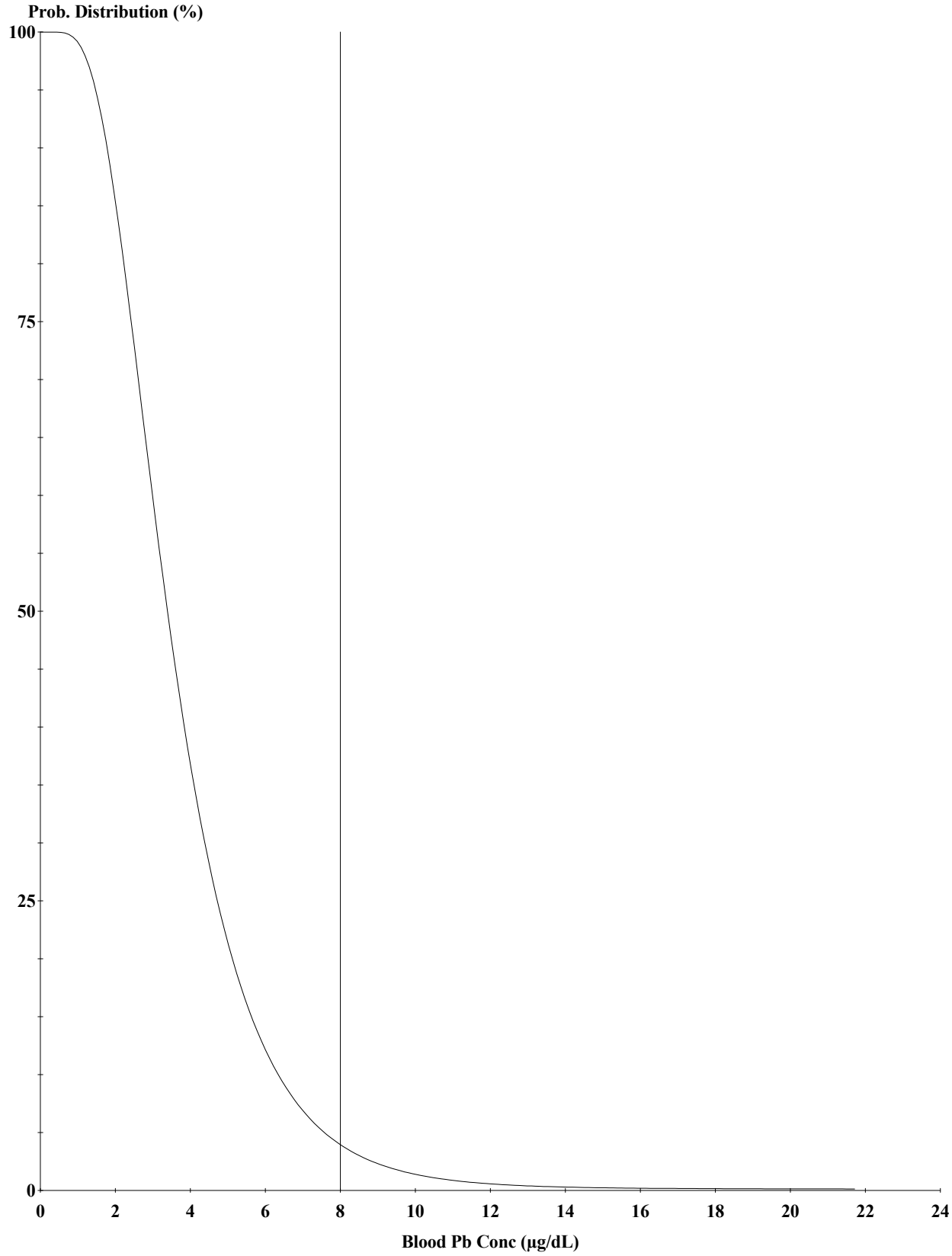


Cutoff = 5.000 µg/dl
Geo Mean = 3.552
GSD = 1.600
% Above = 23.353

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 13. IEUBK Output - Initial Analysis (Beaver Creek) 5 µg/dl

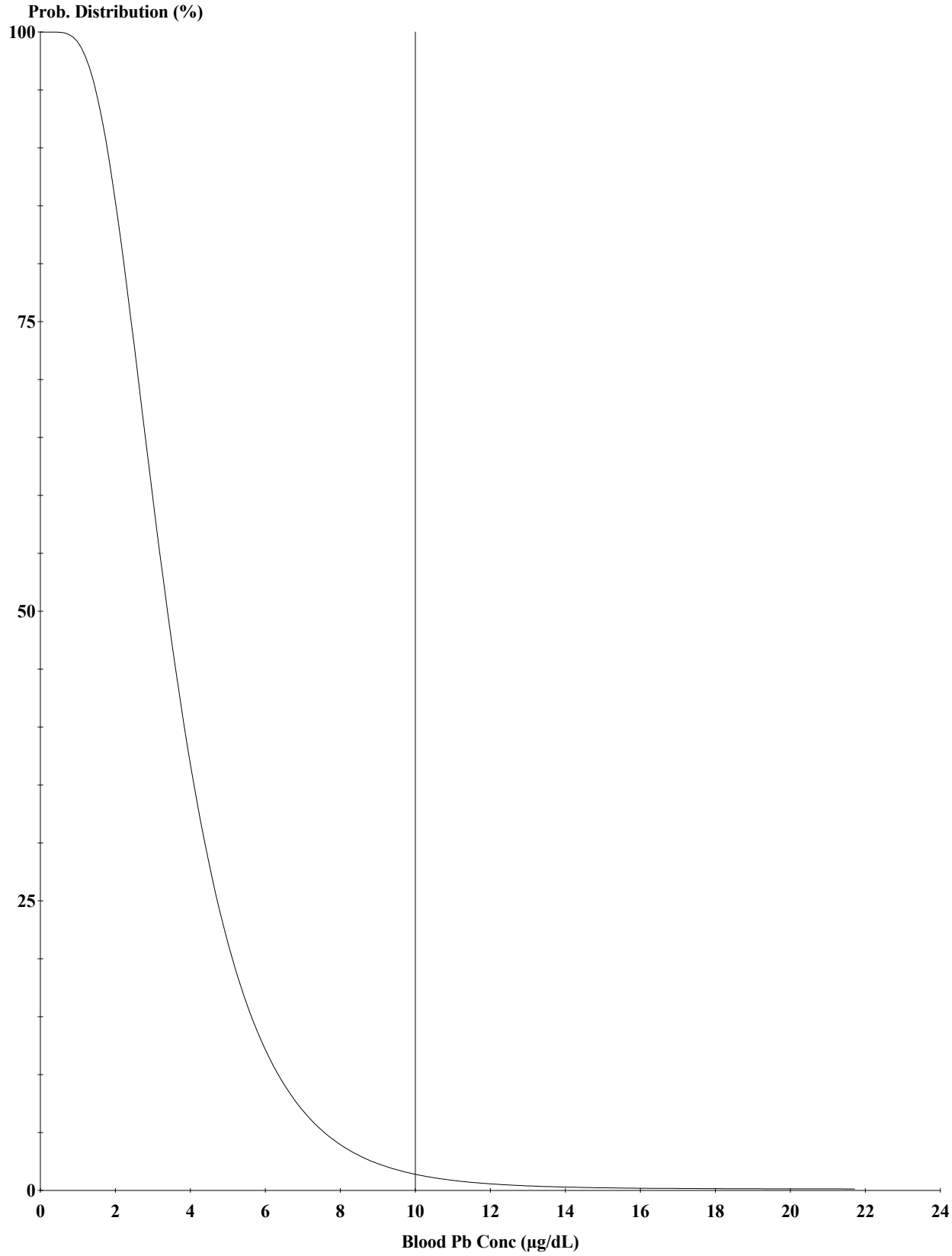


Cutoff = 8.000 µg/dl
Geo Mean = 3.552
GSD = 1.600
% Above = 4.206

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 14. IEUBK Output - Initial Analysis (Beaver Creek) 8 µg/dl

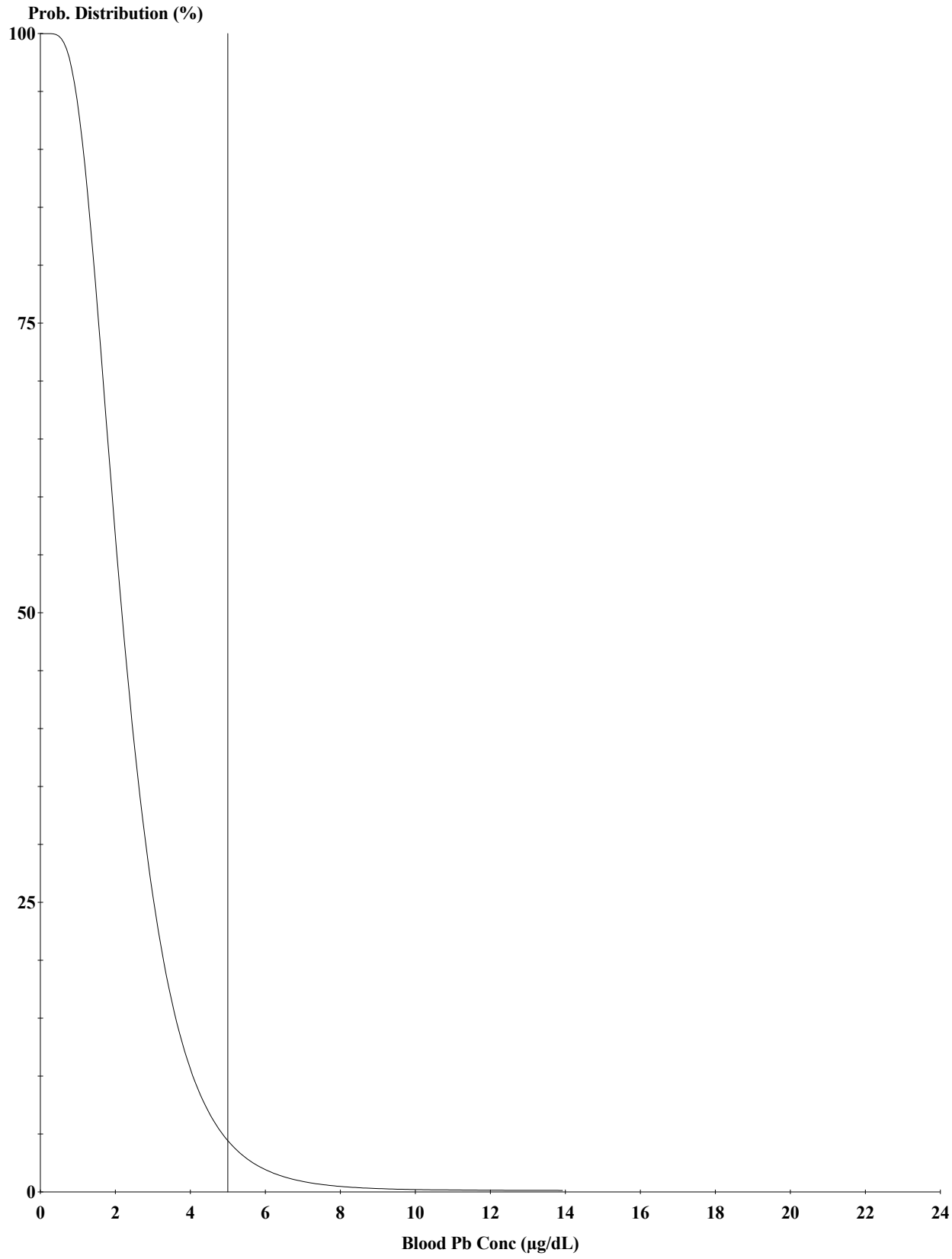


Cutoff = 10.000 µg/dl
Geo Mean = 3.552
GSD = 1.600
% Above = 1.383

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 15. IEUBK Output - Initial Analysis (Beaver Creek) 10 µg/dl

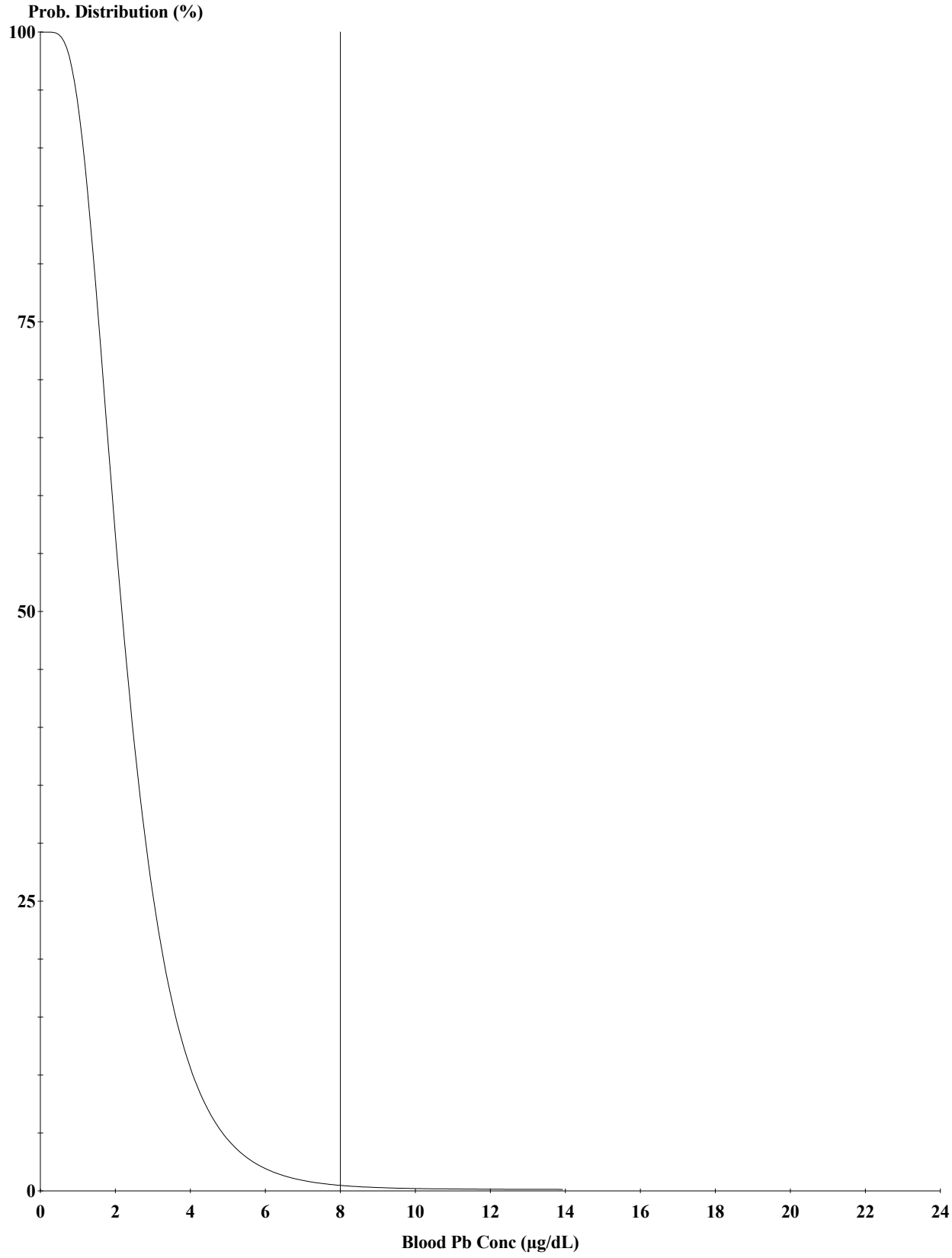


Cutoff = 5.000 µg/dl
Geo Mean = 2.278
GSD = 1.600
% Above = 4.723

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 16. IEUBK Output - Initial Analysis (Lost Creek) 5 µg/dl

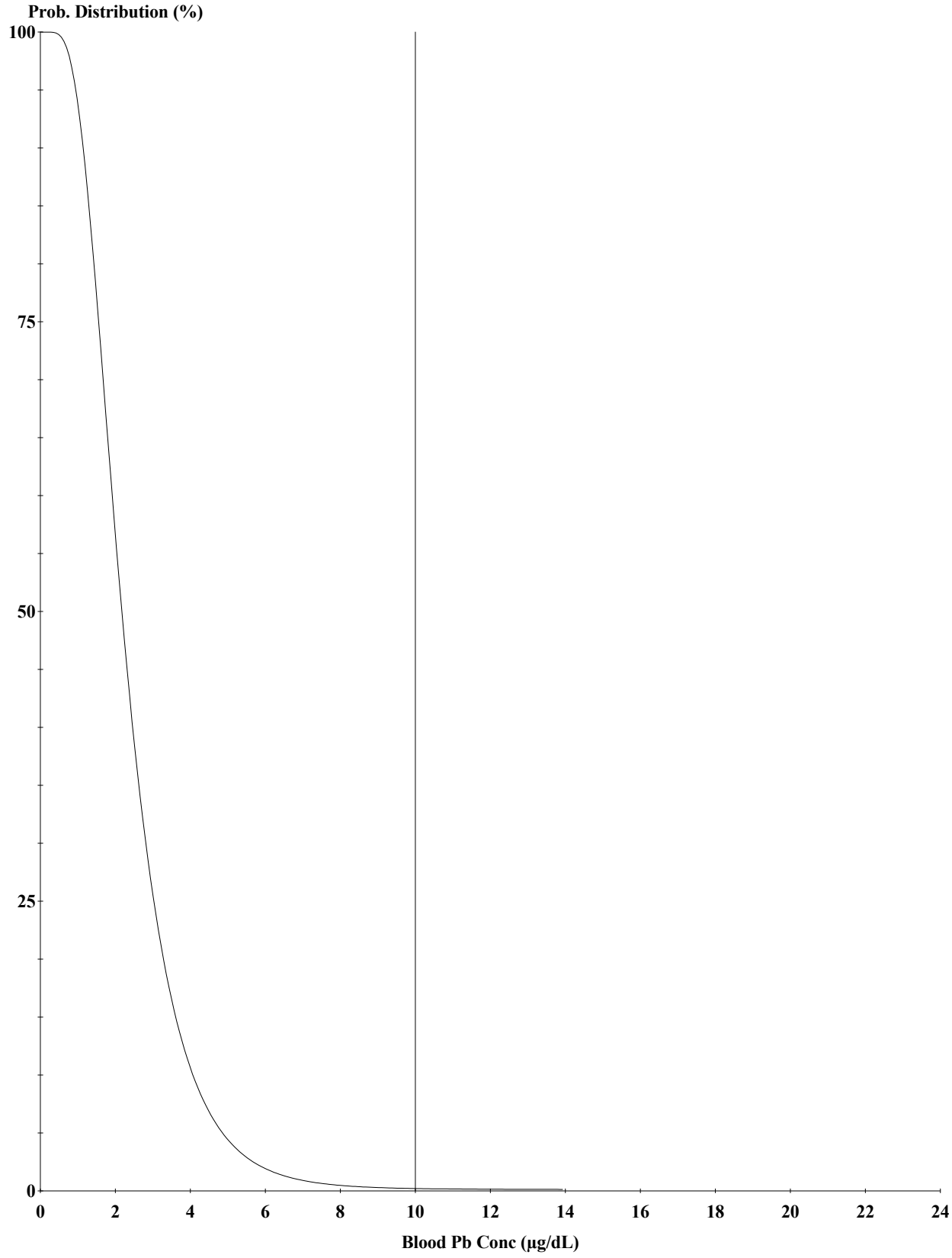


Cutoff = 8.000 µg/dl
Geo Mean = 2.278
GSD = 1.600
% Above = 0.377

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 17. IEUBK Output - Initial Analysis (Lost Creek) 8 µg/dl

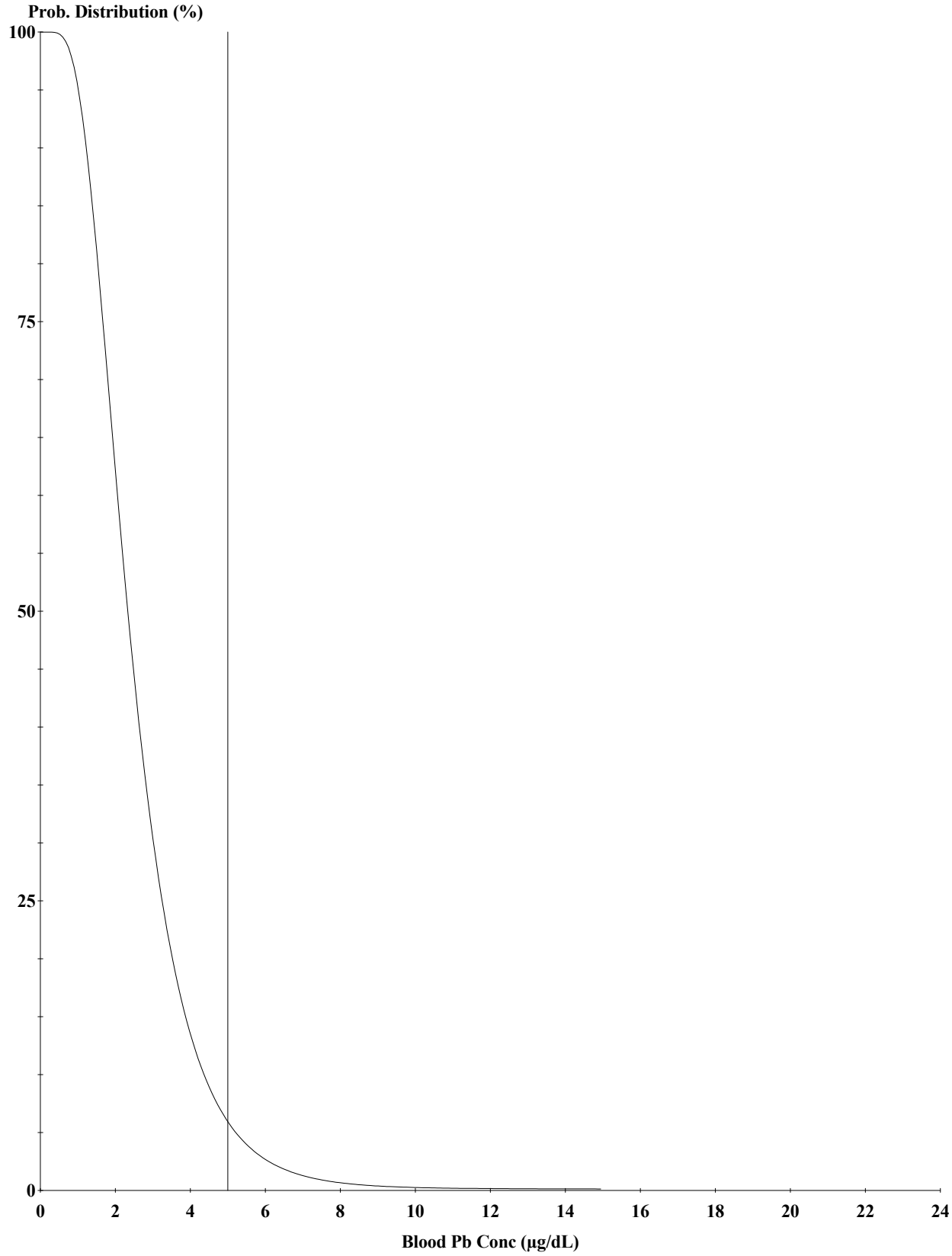


Cutoff = 10.000 µg/dl
Geo Mean = 2.278
GSD = 1.600
% Above = 0.082

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 18. IEUBK Output - Initial Analysis (Lost Creek) 10 µg/dl

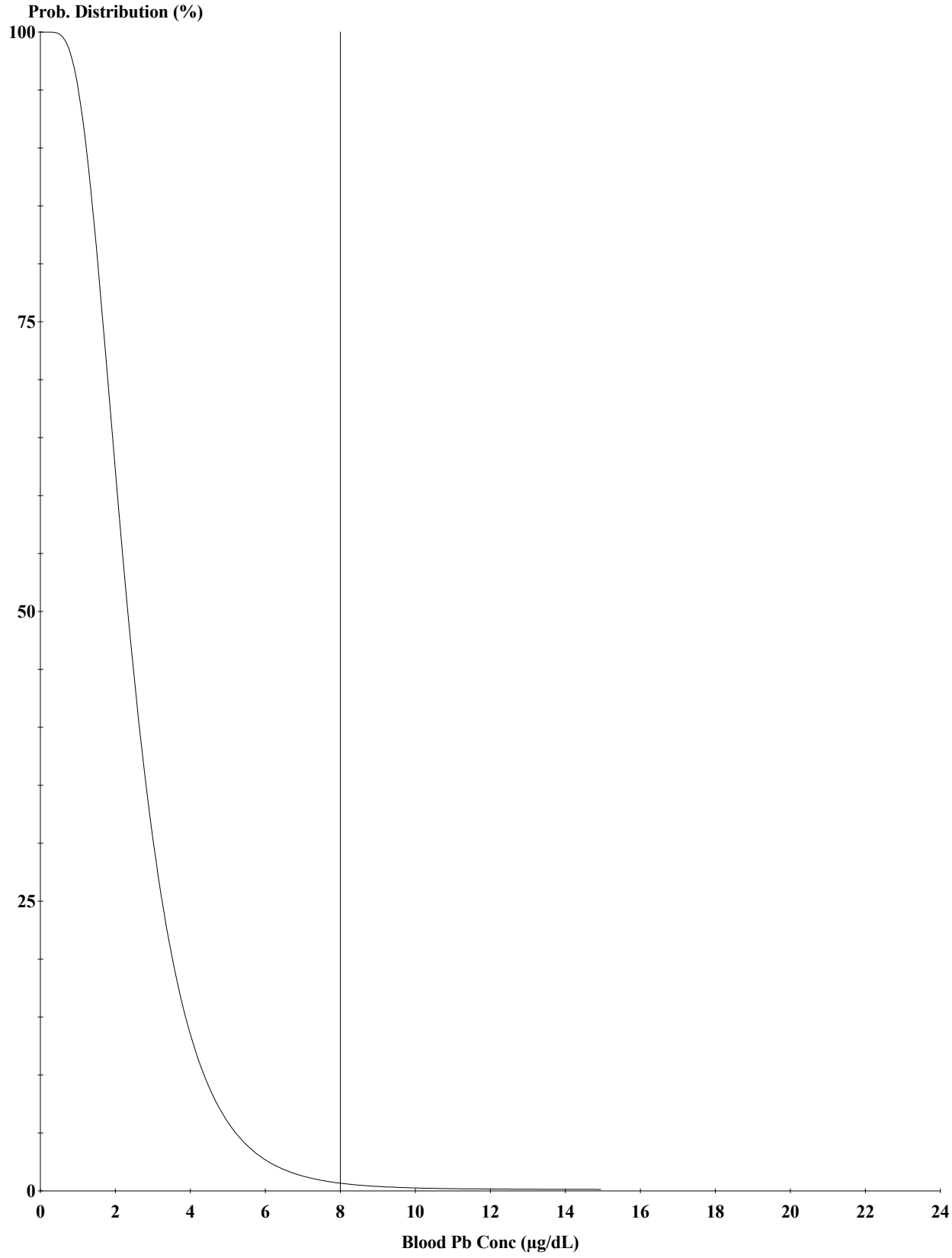


Cutoff = 5.000 µg/dl
Geo Mean = 2.444
GSD = 1.600
% Above = 6.393

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 19. IEUBK Output - Initial Analysis (Lower Spring River) 5 µg/dl

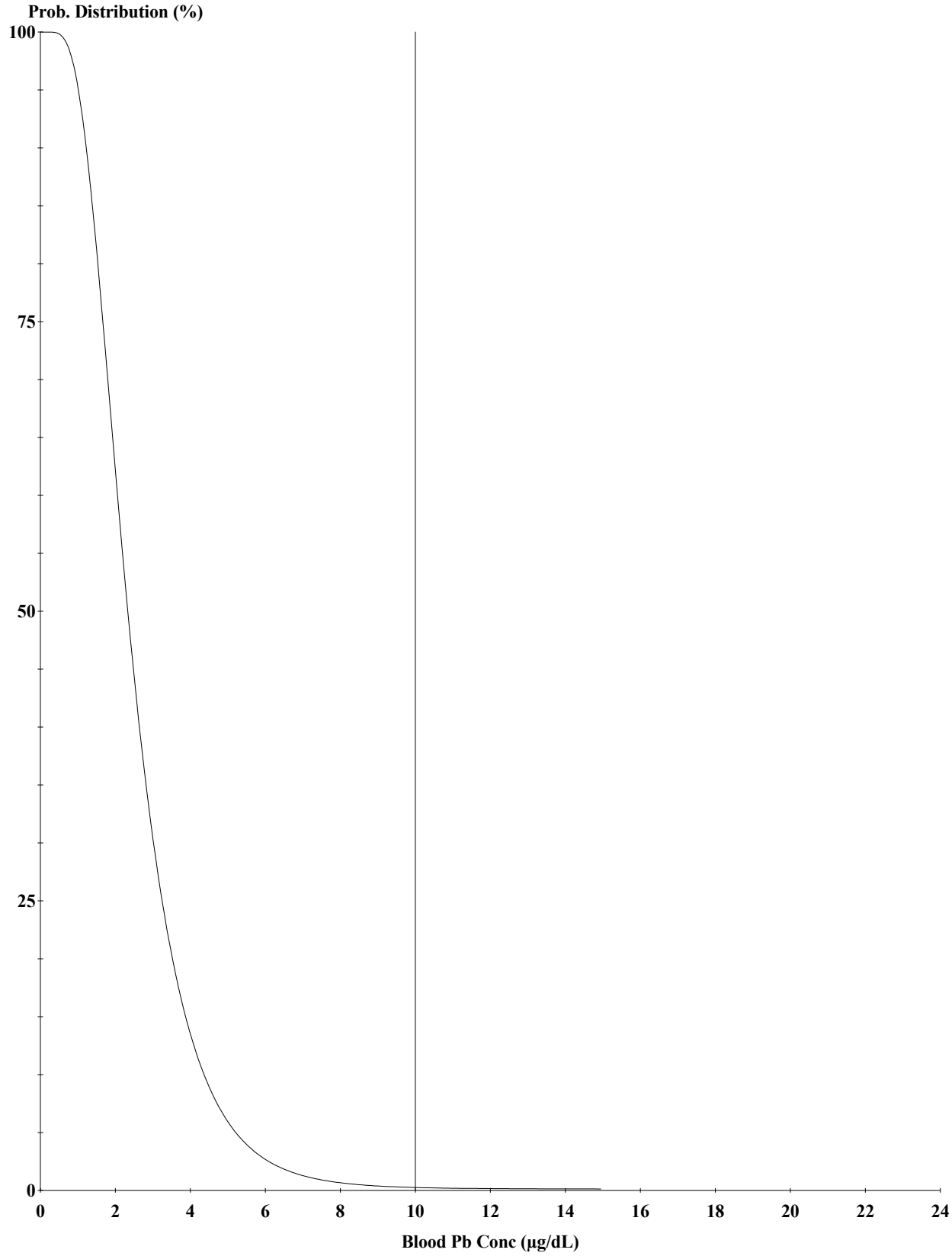


Cutoff = 8.000 µg/dl
Geo Mean = 2.444
GSD = 1.600
% Above = 0.582

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 20. IEUBK Output - Initial Analysis (Lower Spring River) 8 µg/dl



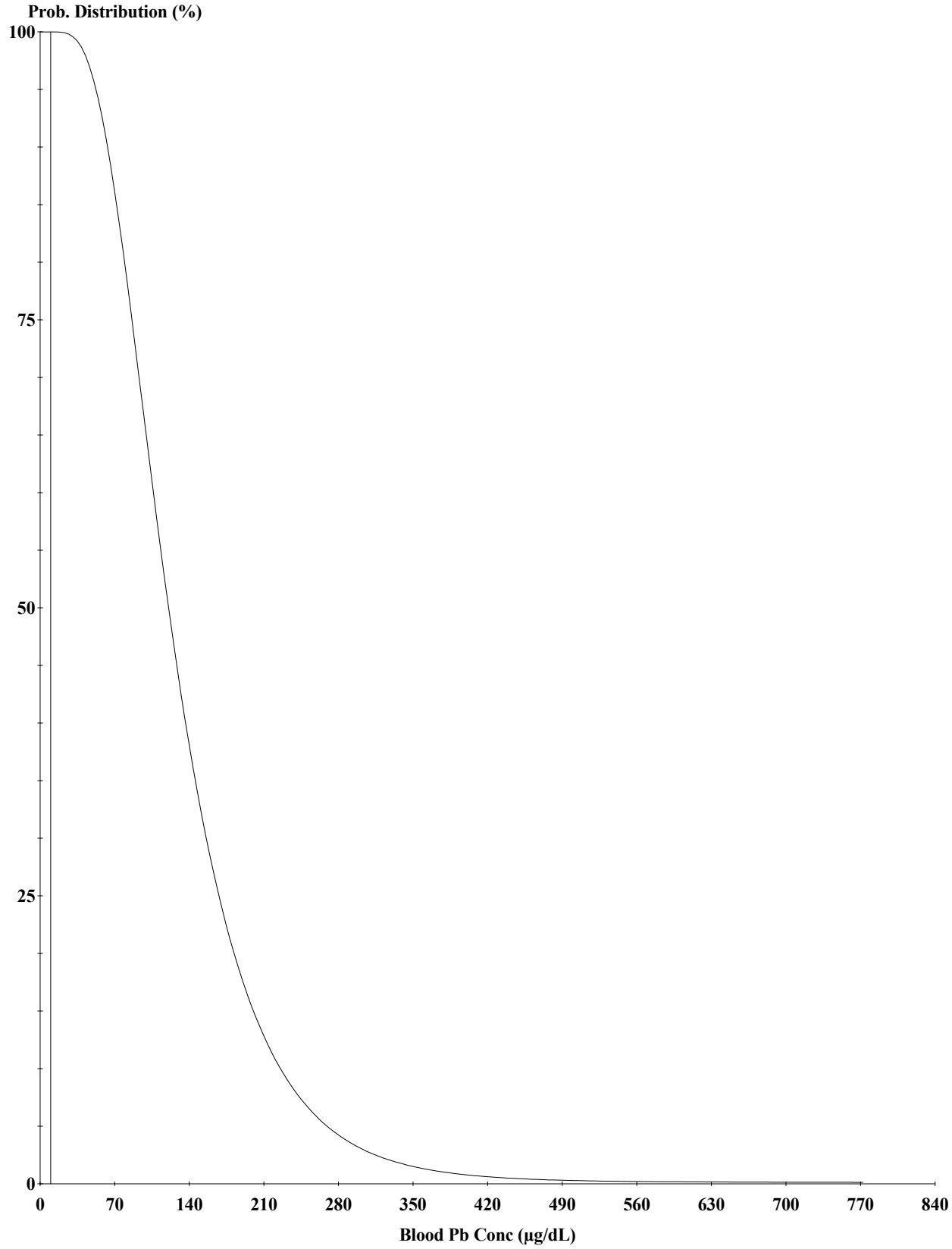
Cutoff = 10.000 µg/dl
Geo Mean = 2.444
GSD = 1.600
% Above = 0.136

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Initial Analysis)

Appendix E. Attachment B, Figure 21. IEUBK Output - Initial Analysis (Lower Spring River) 10 µg/dl

Appendix E. Attachment B, Figure 22. IEUBK Output - Additional Analysis (Fourmile Creek [Reference Site]) 10 µg/dl



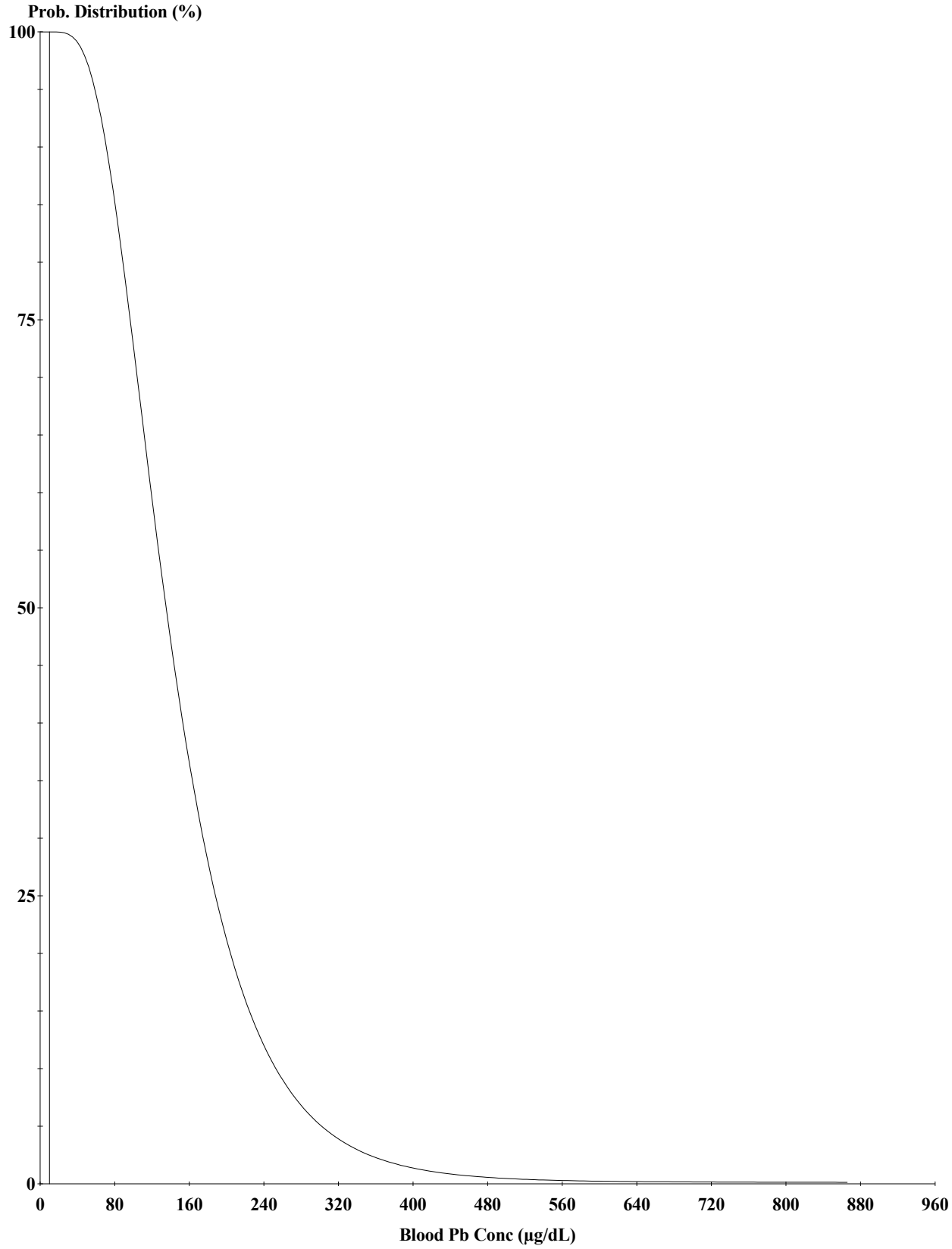
Cutoff = 10.000 µg/dl
Geo Mean = 126.315
GSD = 1.600
% Above = 100.000

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research (Additional Analysis)
Fourmile Creek

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Figure 23. IEUBK Output - Additional Analysis (Elm Creek) 10 µg/dl



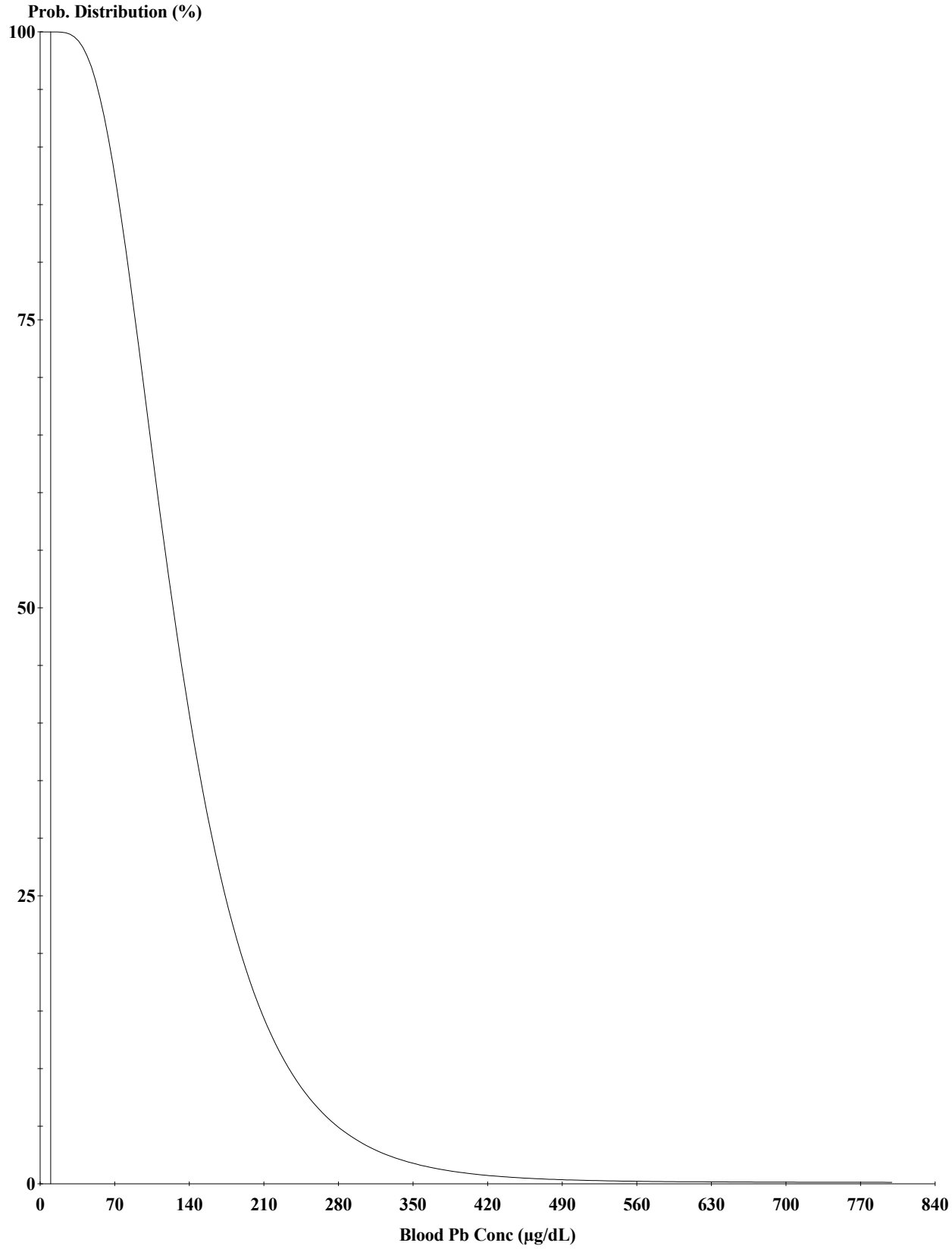
Cutoff = 10.000 µg/dl
Geo Mean = 141.622
GSD = 1.600
% Above = 100.000

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Additional Analysis)

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Figure 24. IEUBK Output - Additional Analysis (Tar Creek) 10 µg/dl



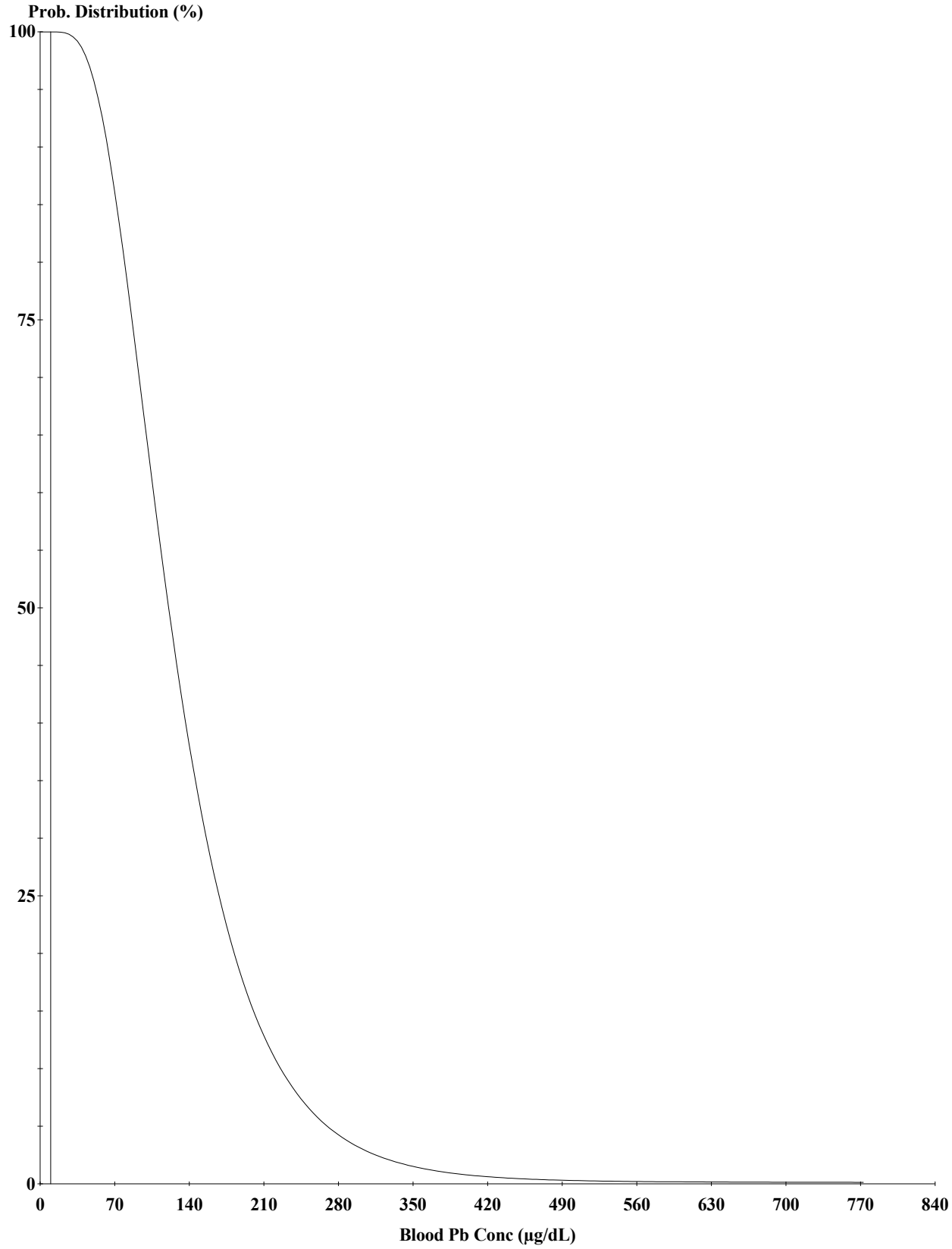
Cutoff = 10.000 µg/dl
Geo Mean = 130.779
GSD = 1.600
% Above = 100.000

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Additional Analysis)

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Figure 25. IEUBK Output - Additional Analysis (Neosho River) 10 µg/dl



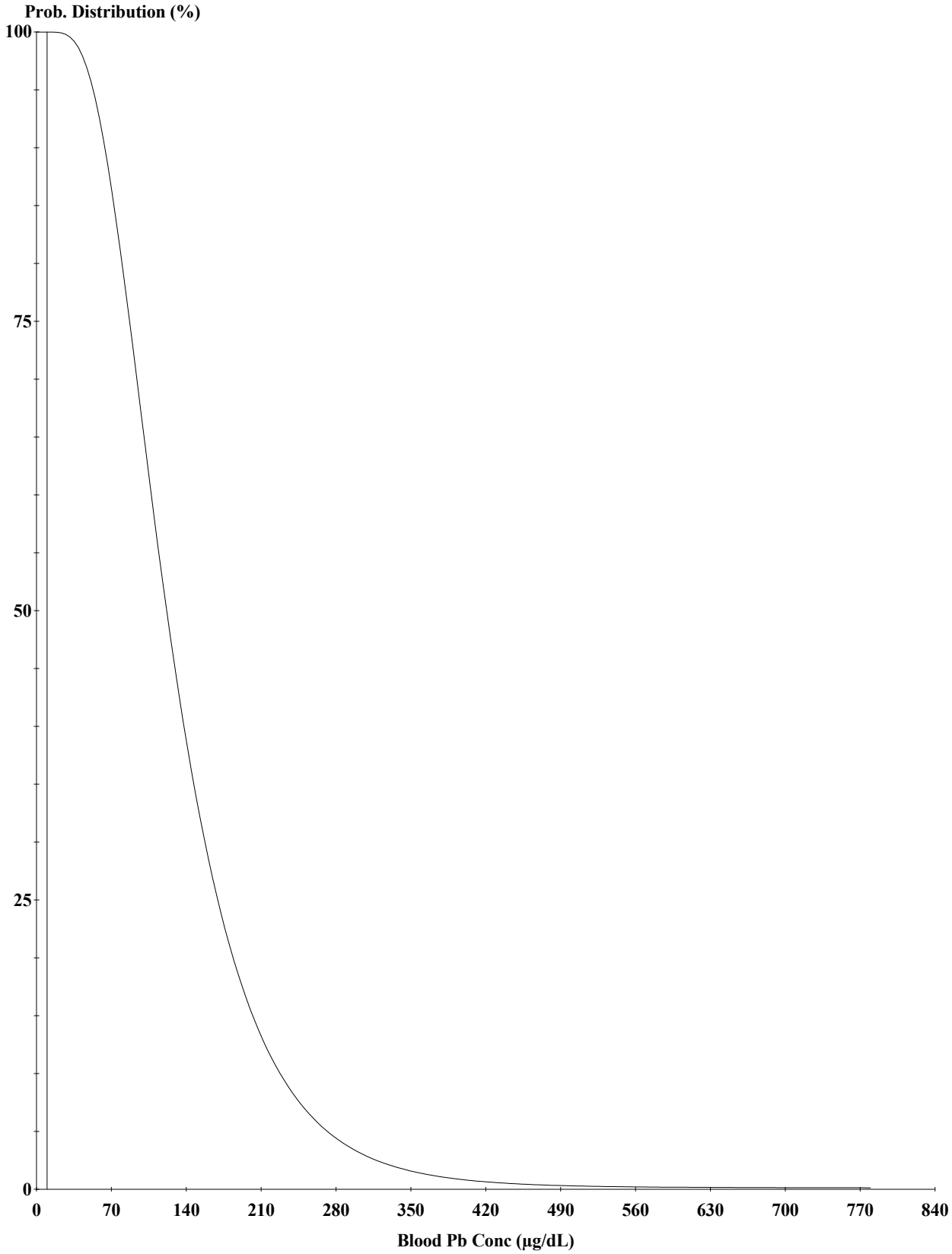
Cutoff = 10.000 µg/dl
Geo Mean = 126.402
GSD = 1.600
% Above = 100.000

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research (Additional Analysis)
Neosho River

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Figure 26. IEUBK Output - Additional Analysis (Beaver Creek) 10 µg/dl



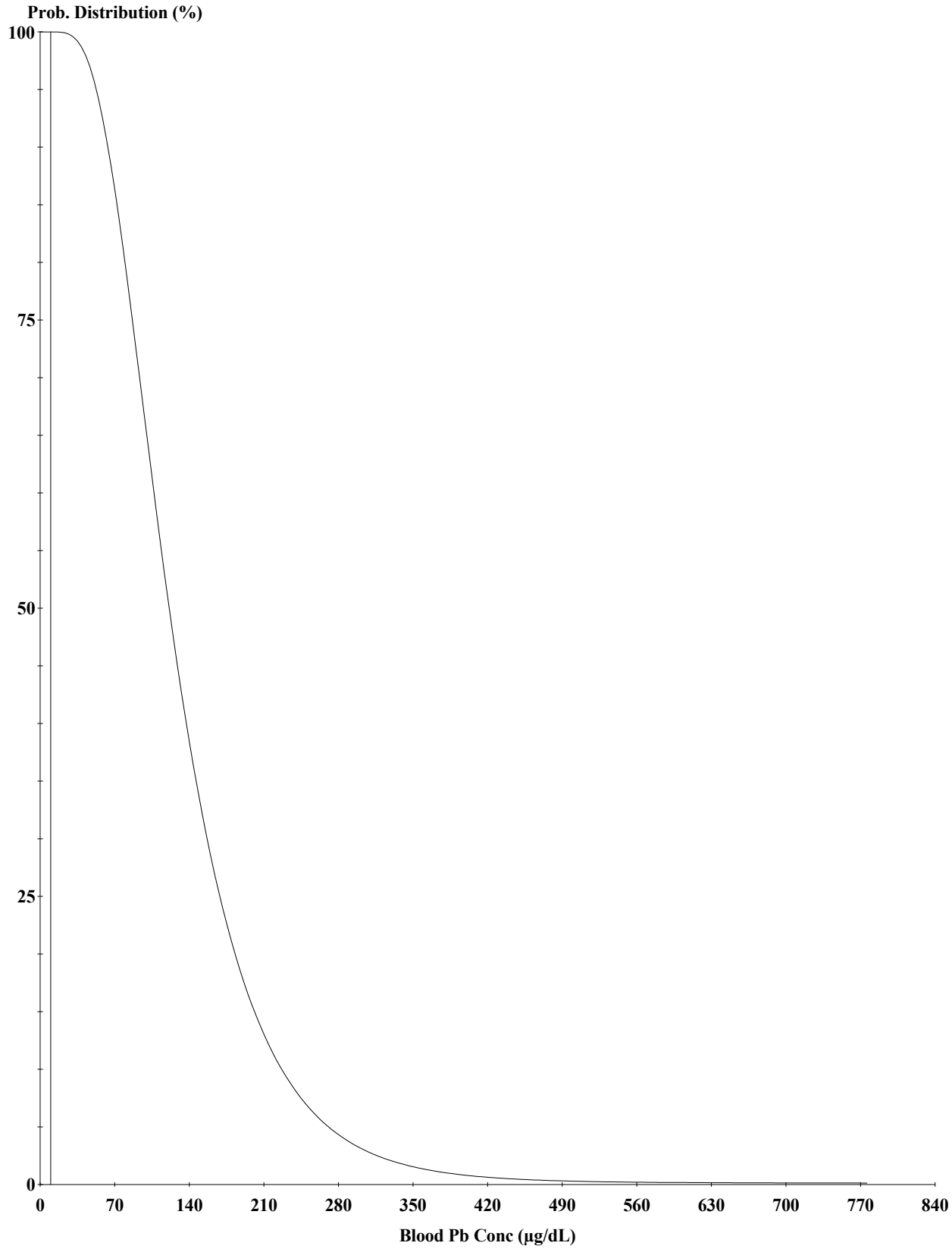
Cutoff = 10.000 µg/dl
Geo Mean = 127.543
GSD = 1.600
% Above = 100.000

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research (Additional Analysis)
Beaver Creek

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Figure 27. IEUBK Output - Additional Analysis (Lost Creek) 10 µg/dl



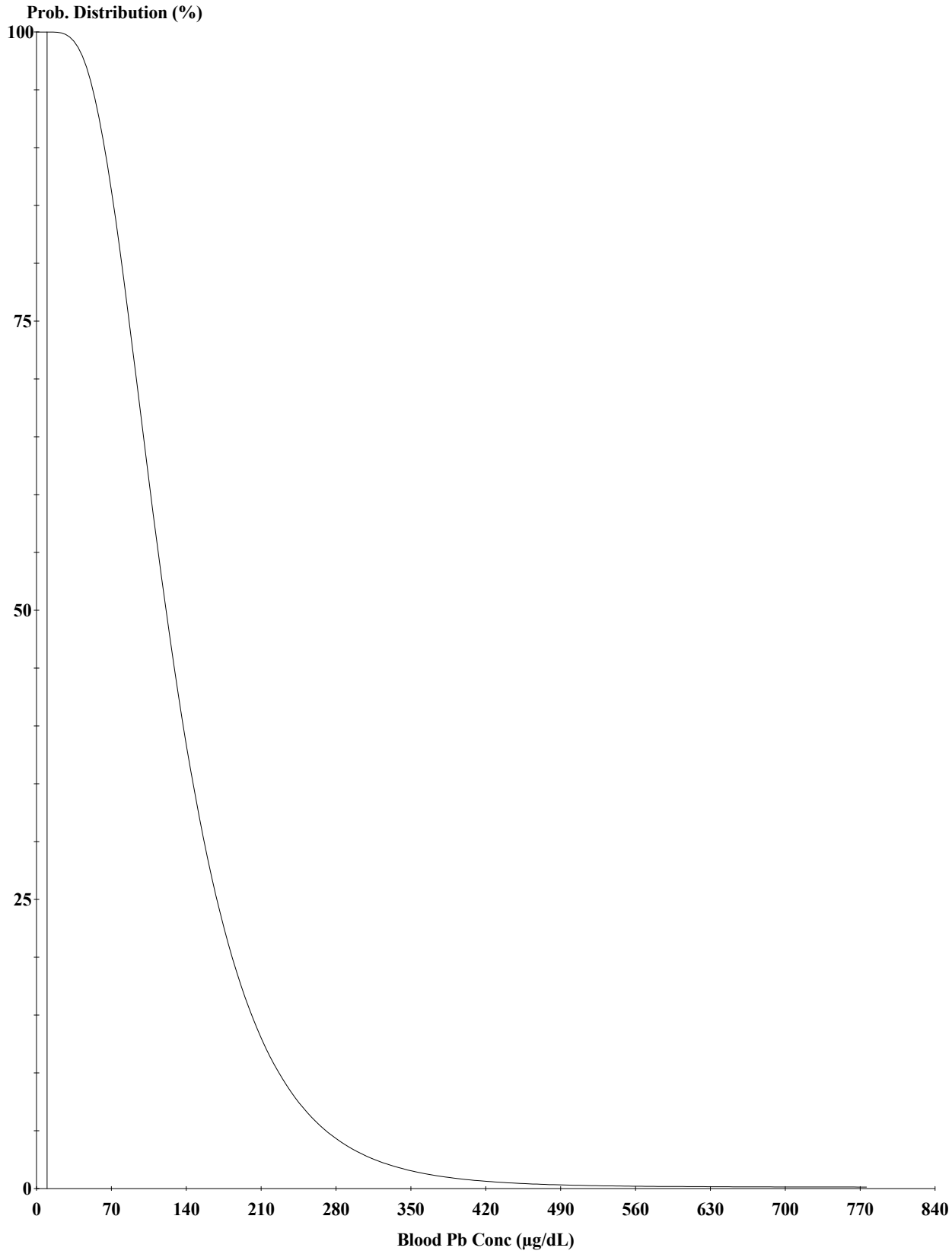
Cutoff = 10.000 µg/dl
Geo Mean = 126.954
GSD = 1.600
% Above = 100.000

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research (Additional Analysis) Lost Creek

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

Appendix E. Attachment B, Figure 28. IEUBK Output - Additional Analysis (Lower Spring River) 10 µg/dl

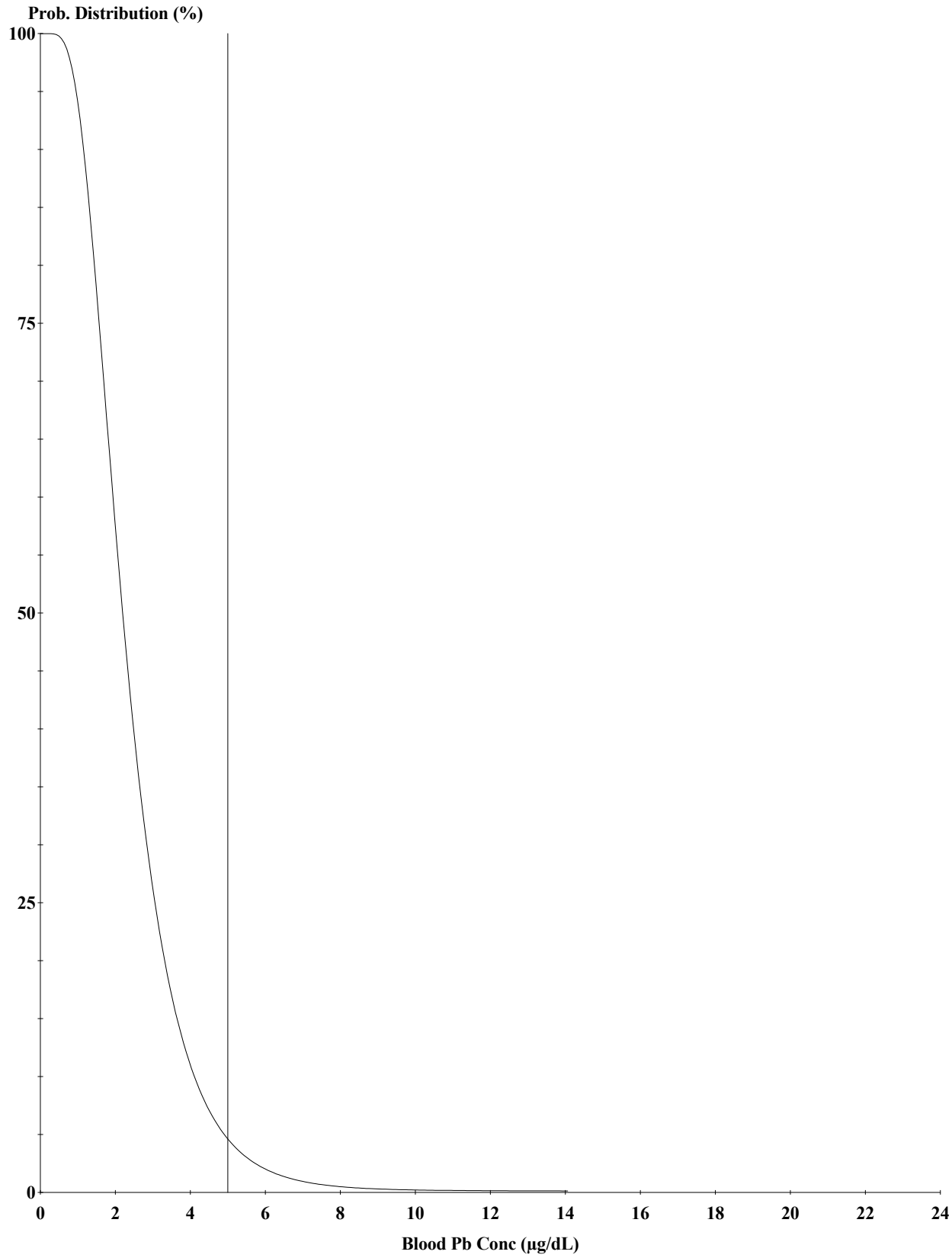


Cutoff = 10.000 µg/dl
Geo Mean = 126.918
GSD = 1.600
% Above = 100.000

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research (Additional Analysis)
Lower Spring River

Environmental exposures associated with blood lead levels above 30 µg/dl are above the range of values that have been used in the calibration and empirical validation of this model. (Zaragoza, L. and Hogan, K. 1998. The Integrated Exposure Uptake Biokinetic Model for Lead In Children: Independent Validation and Verification. Environmental Health Perspectives 106 (supplement 6). p. 1555)

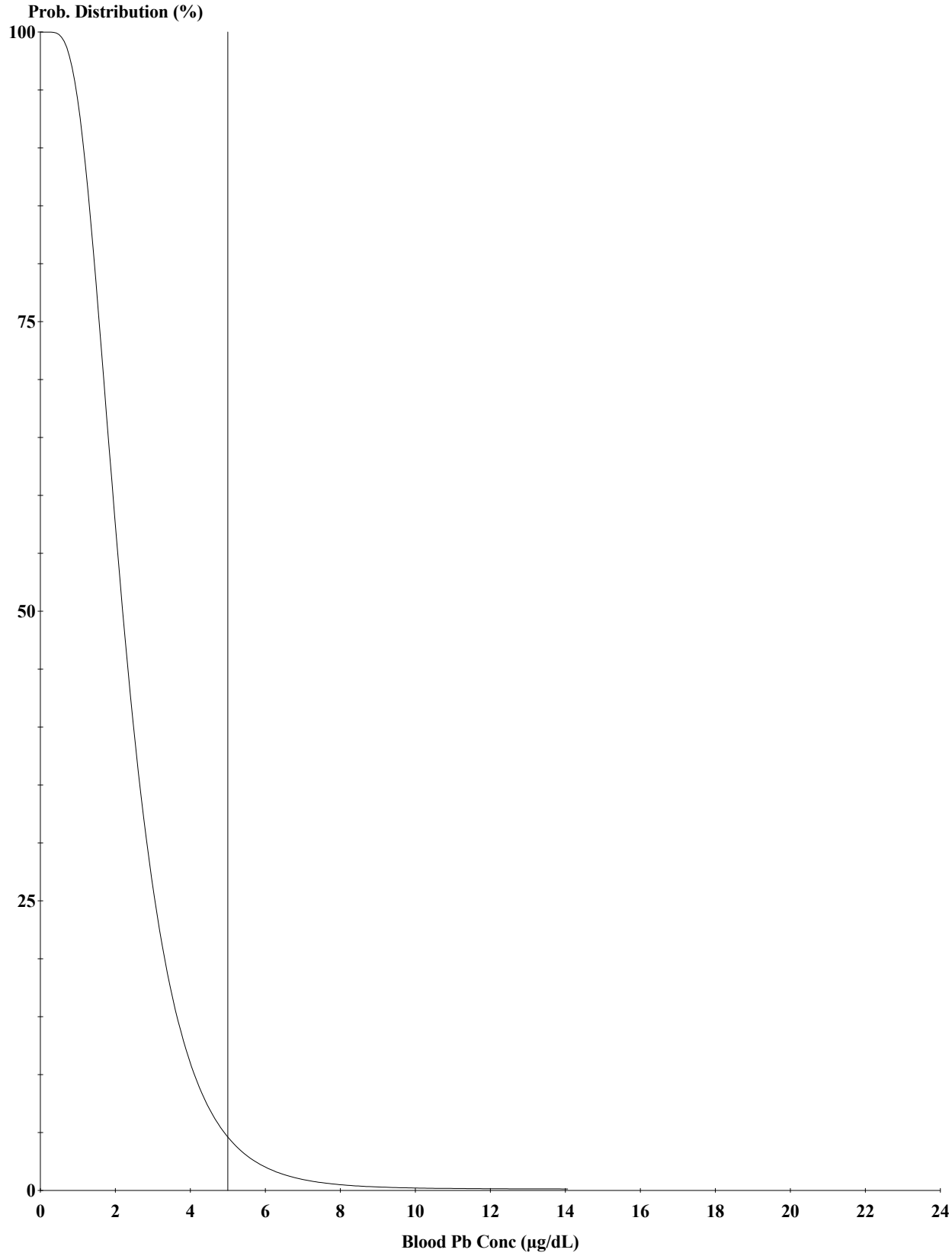


Cutoff = 5.000 µg/dl
Geo Mean = 2.301
GSD = 1.600
% Above = 4.930

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Identification of Target Sediment Concentration)

Appendix E. Attachment B, Figure 29. IEUBK Output - Identification of Target Sediment Concentration (Fourmile Creek [Reference Site]) 5 µg/dl

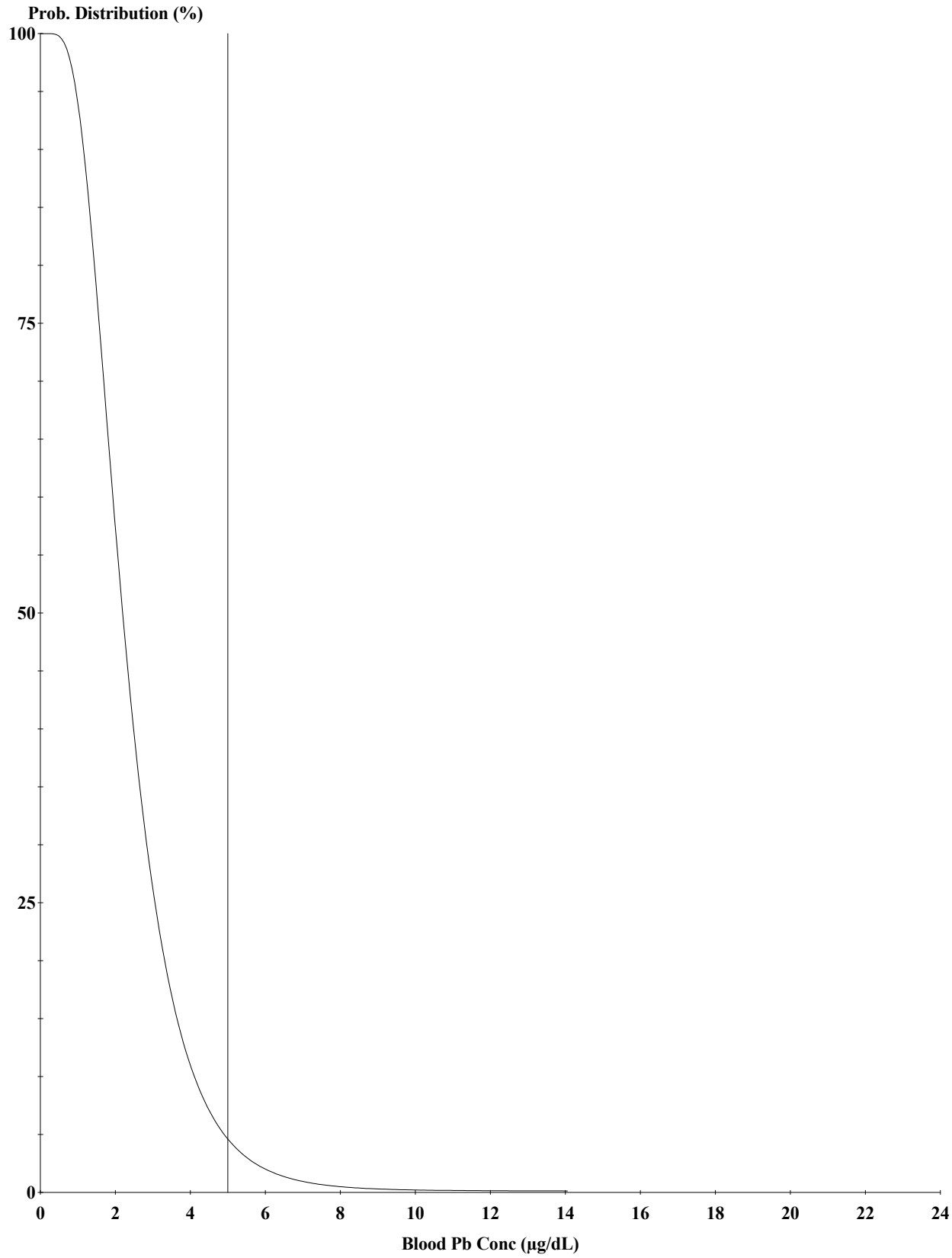


Cutoff = 5.000 µg/dl
Geo Mean = 2.300
GSD = 1.600
% Above = 4.928

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Identification of Target Sediment Concentration)

Appendix E. Attachment B, Figure 30. IEUBK Output - Identification of Target Sediment Concentration (Neosho River) 5 µg/dl

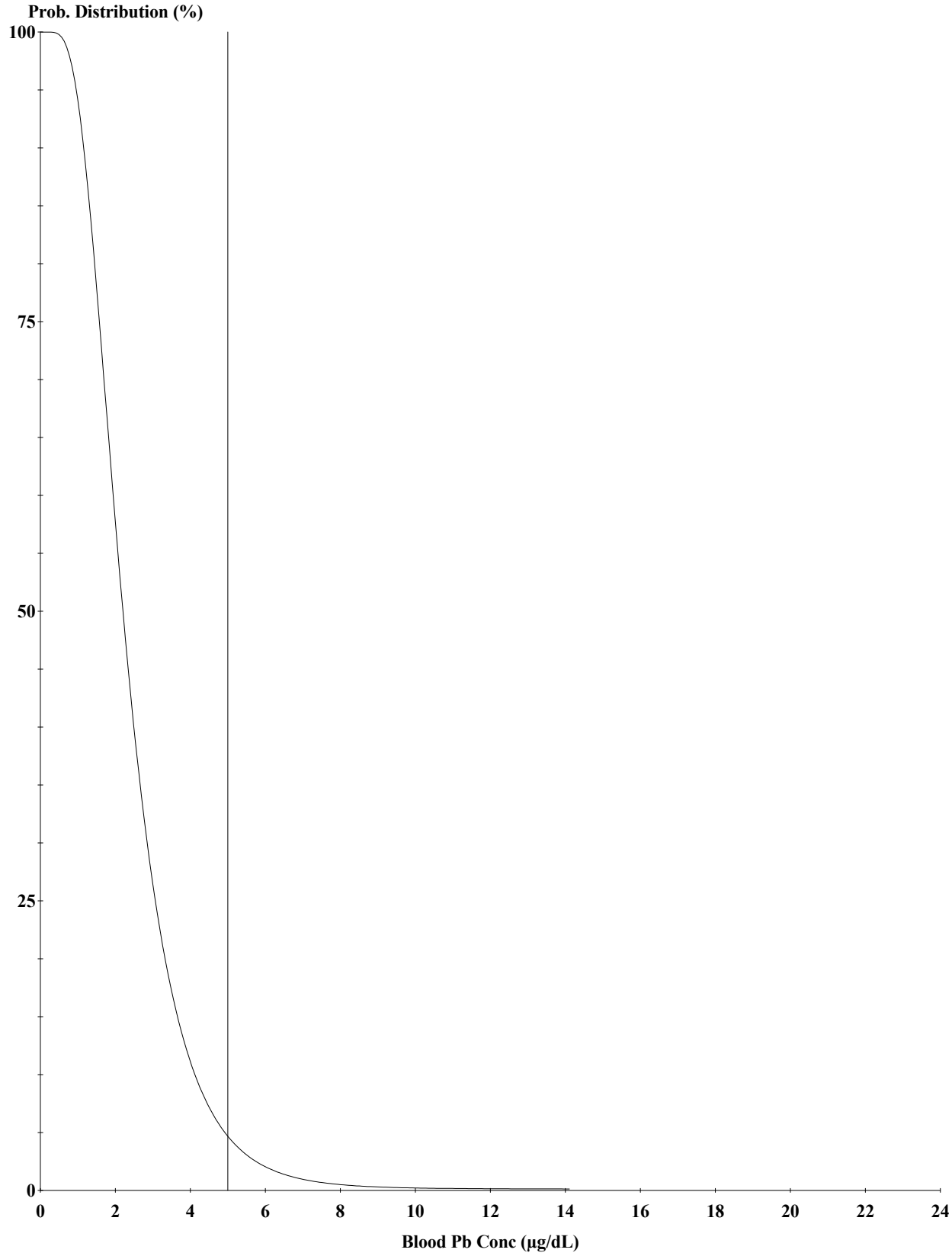


Cutoff = 5.000 µg/dl
Geo Mean = 2.300
GSD = 1.600
% Above = 4.923

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Identification of Target Sediment Concentration)

Appendix E. Attachment B, Figure 31. IEUBK Output - Identification of Target Sediment Concentration (Beaver Creek) 5 µg/dl

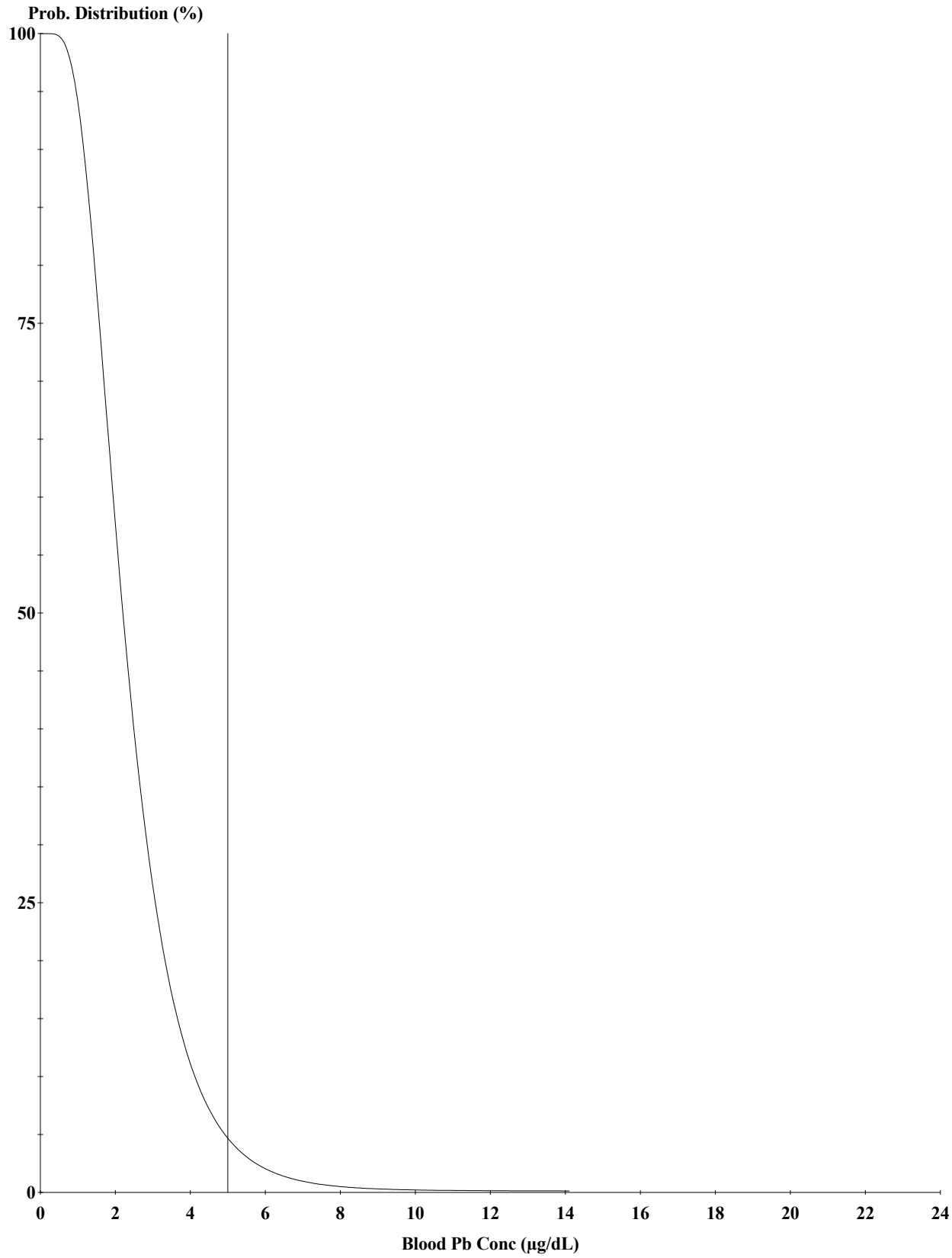


Cutoff = 5.000 µg/dl
Geo Mean = 2.308
GSD = 1.600
% Above = 5.002

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Identification of Target Sediment Concentration)

Appendix E. Attachment B, Figure 32. IEUBK Output - Identification of Target Sediment Concentration (Lost Creek) 5 µg/dl



Cutoff = 5.000 µg/dl
Geo Mean = 2.308
GSD = 1.600
% Above = 4.998

Age Range = User Designated: Ages 12 - 72 months

Run Mode = Research
Comment = Research (Identification of Target Sediment Concentration)

Appendix E. Attachment B, Figure 33. IEUBK Output - Identification of Target Sediment Concentration (Lower Spring River) 5 µg/dl

Attachment C
Adult Lead Methodology (ALM) Output

Appendix E. Attachment C, Table 1. Calculations of Blood Lead Concentrations (PbBs) and Risk in Nonresidential Areas
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

GSDi and PbBo from Analysis of NHANES 2009-2014

Variable	Description of Variable	Units	Fourmile Creek	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
PbS	Sediment lead concentration	µg/g or ppm	27	4281	1095	37.8	275	168	146
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.8	1.8	1.8	1.8	1.8	1.8
PbB_0	Baseline PbB	µg/dL	0.6	0.6	0.6	0.6	0.6	0.6	0.6
IR_S	Sediment ingestion rate (including soil-derived indoor dust)	g/day	0.100	0.100	0.100	0.100	0.100	0.100	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--	--
K_{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--	--
$AF_{S, D}$	Absorption fraction (same as soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S, D}$	Exposure frequency (sediment)	days/yr	219	219	219	219	219	219	219
$AT_{S, D}$	Averaging time (sediment)	days/yr	365	365	365	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.7	12.9	3.8	0.7	1.4	1.1	1.0
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	1.6	30.6	8.9	1.7	3.3	2.6	2.4
PbB_t	Target PbB level of concern (e.g., 2-8 ug/dL)	µg/dL	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB exceeds target PbB, assuming lognormal distribution**	**%**	**0.02%**	**92.5%**	**25.2%**	**0.02%**	**0.93%**	**0.27%**	**0.20%**

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.

Appendix E. Attachment C, Table 2. Calculations of Blood Lead Concentrations (PbBs) and Risk in Nonresidential Areas
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

			GSDi and PbBo from Analysis of NHANES 2009-2014						
Variable	**Description of Variable**	**Units**	**Fourmile Creek**	**Elm Creek**	**Tar Creek**	**Neosho River**	**Beaver Creek**	**Lost Creek**	**Lower Spring River**
PbS	Sediment lead concentration	µg/g or ppm	27	4281	1095	37.8	275	168	146
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.8	1.8	1.8	1.8	1.8	1.8
PbB_0	Baseline PbB	µg/dL	0.6	0.6	0.6	0.6	0.6	0.6	0.6
IR_S	Sediment ingestion rate (including soil-derived indoor dust)	g/day	0.100	0.100	0.100	0.100	0.100	0.100	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--	--
K_{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--	--
$AF_{S, D}$	Absorption fraction (same as soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S, D}$	Exposure frequency (sediment)	days/yr	219	219	219	219	219	219	219
$AT_{S, D}$	Averaging time (sediment)	days/yr	365	365	365	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.7	12.9	3.8	0.7	1.4	1.1	1.0
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	1.6	30.6	8.9	1.7	3.3	2.6	2.4
PbB_t	Target PbB level of concern (e.g., 2-8 ug/dL)	µg/dL	**8.0**	**8.0**	**8.0**	**8.0**	**8.0**	**8.0**	**8.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB exceeds target PbB, assuming lognormal distribution**	**%**	**0.0006%**	**73.8%**	**7.12%**	**0.0008%**	**0.08%**	**0.017%**	**0.012%**

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead
for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.

Appendix E. Attachment C, Table 3. Calculations of Blood Lead Concentrations (PbBs) and Risk in Nonresidential Areas
U.S. EPA Technical Review Workgroup for Lead

Version date 06/14/2017

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

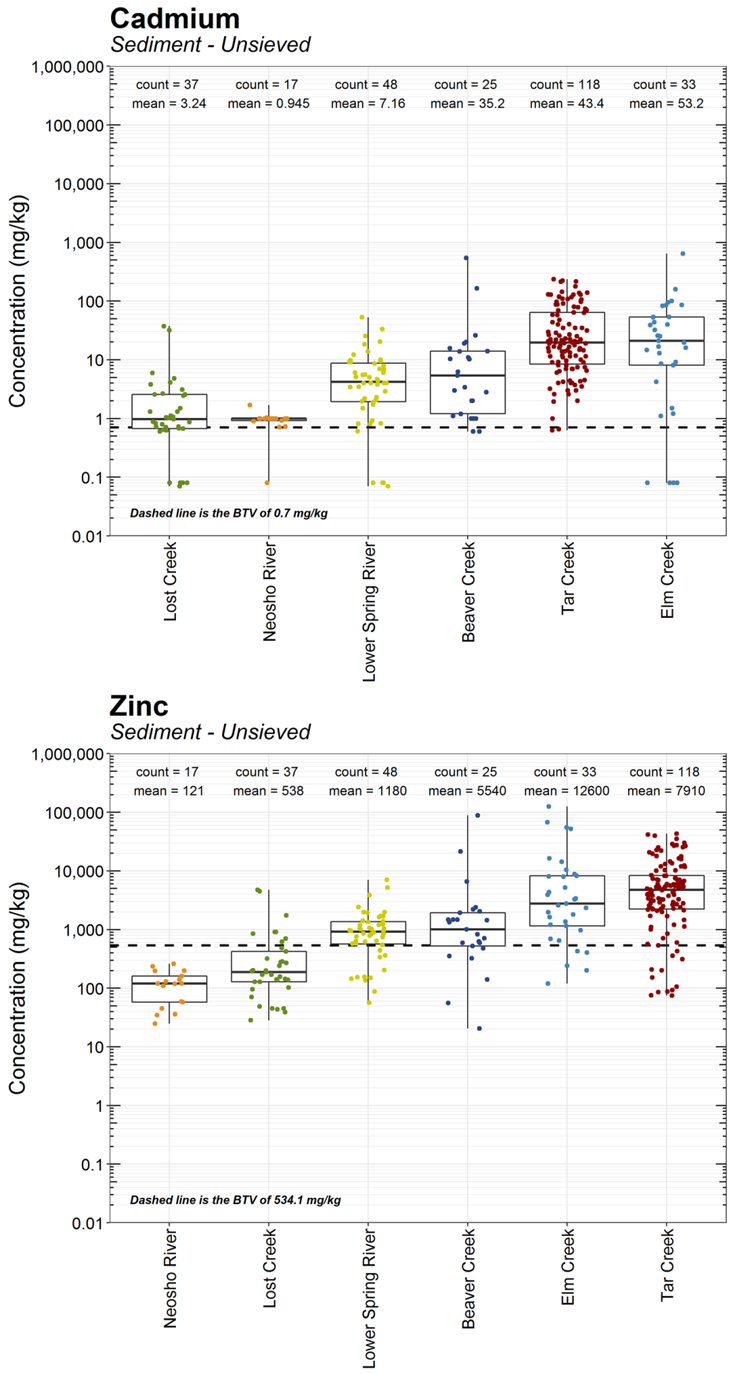
Ottawa County, Oklahoma

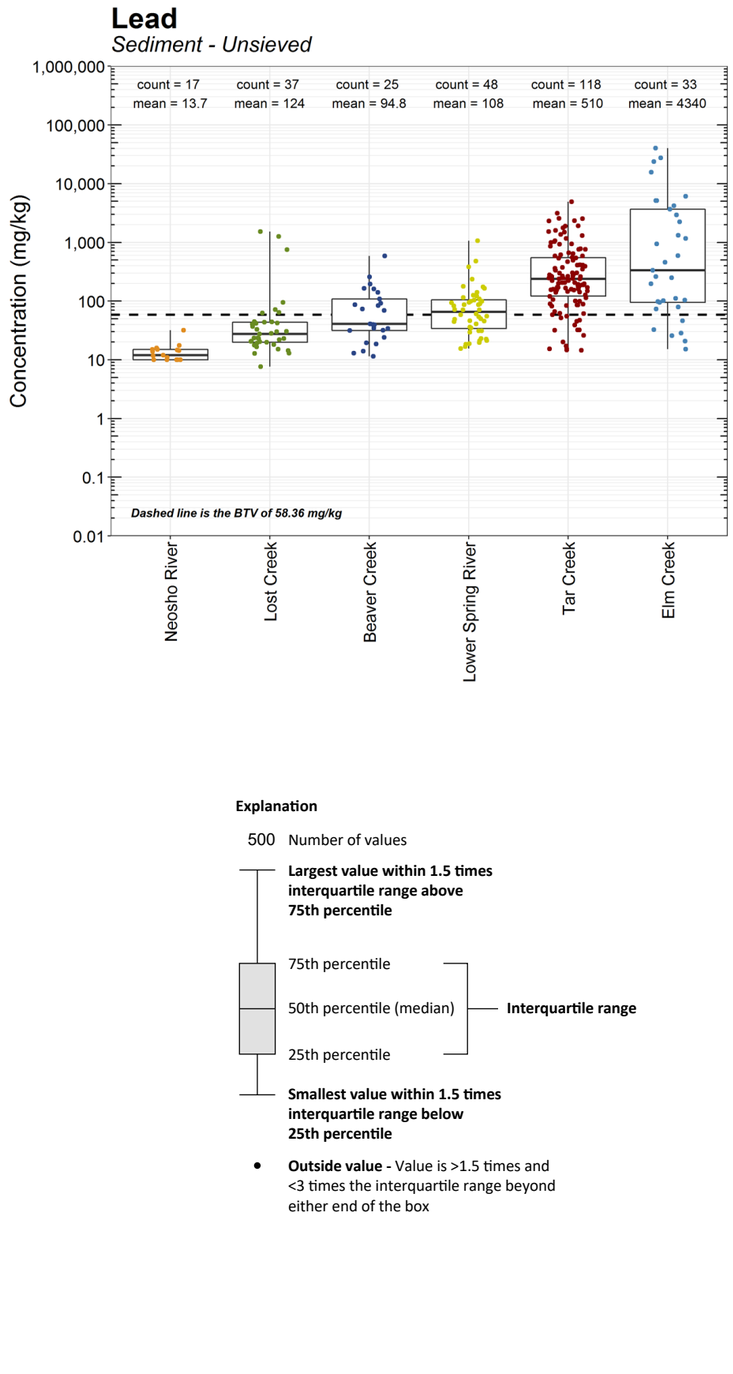
GSDi and PbBo from Analysis of NHANES 2009-2014

Variable	Description of Variable	Units	Fourmile Creek	Elm Creek	Tar Creek	Neosho River	Beaver Creek	Lost Creek	Lower Spring River
PbS	Sediment lead concentration	µg/g or ppm	27	4281	1095	37.8	275	168	146
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	1.8	1.8	1.8	1.8	1.8	1.8	1.8
PbB_0	Baseline PbB	µg/dL	0.6	0.6	0.6	0.6	0.6	0.6	0.6
IR_S	Sediment ingestion rate (including soil-derived indoor dust)	g/day	0.100	0.100	0.100	0.100	0.100	0.100	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--	--	--	--
K_{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--	--
$AF_{S,D}$	Absorption fraction (same as soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12
$EF_{S,D}$	Exposure frequency (sediment)	days/yr	219	219	219	219	219	219	219
$AT_{S,D}$	Averaging time (sediment)	days/yr	365	365	365	365	365	365	365
PbB_{adult}	PbB of adult worker, geometric mean	µg/dL	0.7	12.9	3.8	0.7	1.4	1.1	1.0
$PbB_{fetal,\ 0.95}$	95th percentile PbB among fetuses of adult workers	µg/dL	1.6	30.6	8.9	1.7	3.3	2.6	2.4
PbB_t	Target PbB level of concern (e.g., 2-8 ug/dL)	µg/dL	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB exceeds target PbB, assuming lognormal distribution**	**%**	**0.0001%**	**60.2%**	**3.24%**	**0.00014%**	**0.020%**	**0.004%**	**0.002%**

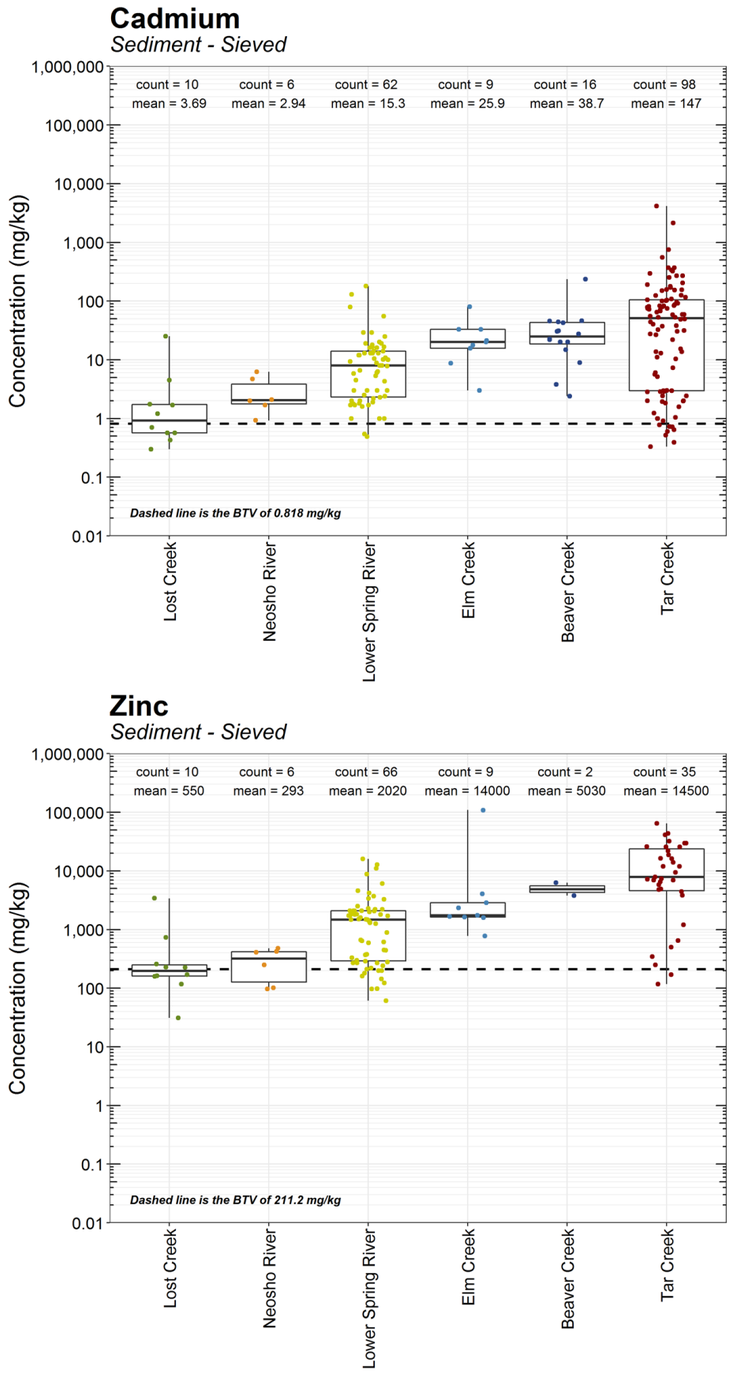
Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil.

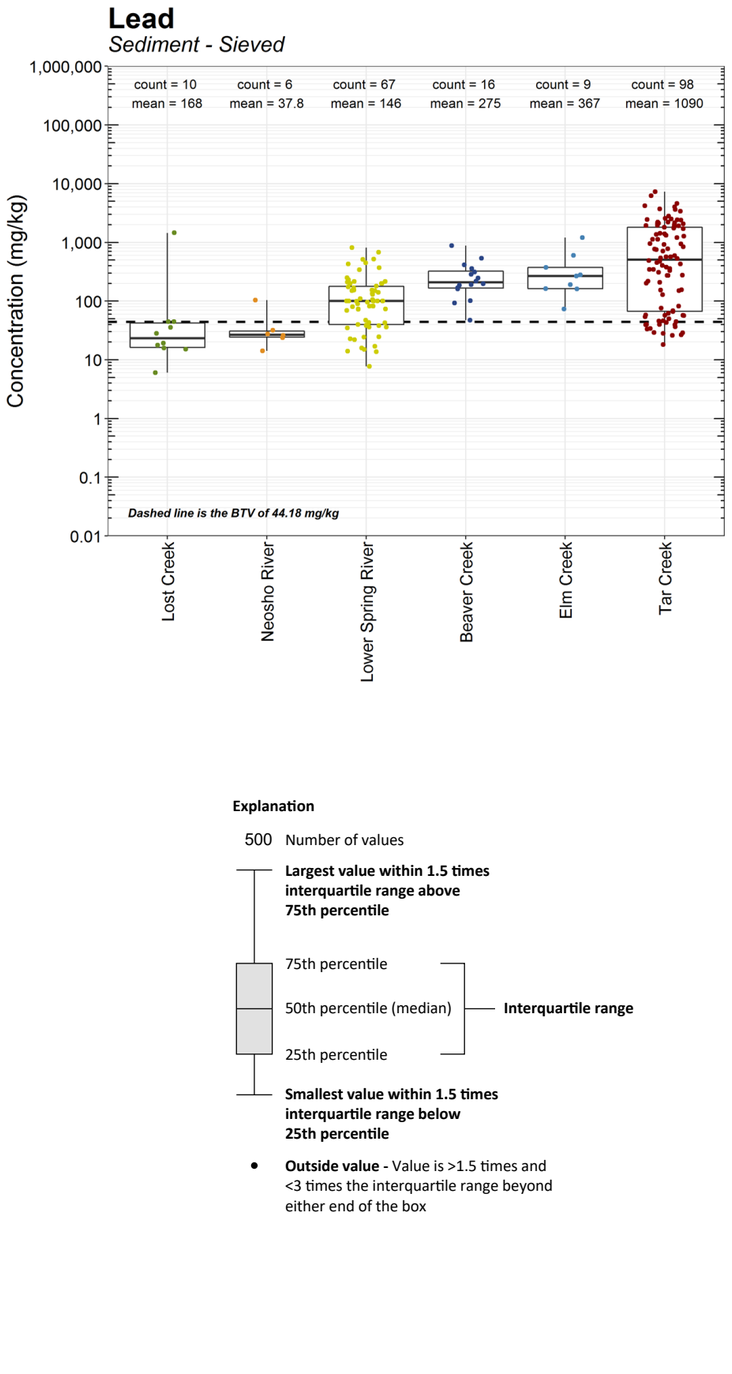
Appendix F
Uncertainty Analysis





Appendix F1. Figure 1.
Boxplot of Unsieved Sediment Cd, Pb, and Zn Concentrations in Study Area Watersheds
Tar Creek Superfund Site
Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma





Appendix F1. Figure 1.
Boxplot of Sieved Sediment Cd, Pb, and Zn Concentrations in Study Area Watersheds
Tar Creek Superfund Site
Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Appendix F2, Table 1. Comparison of Noncarcinogenic Hazard Estimates between Total Metal and Dissolved Metal Data

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Surface Water COC	Target Organ		Hazard Quotient											
				Total Metal						Dissolved Metal					
				EPC	SW (Potable Use)		SW (Sweat Lodge)			EPC	SW (Potable Use)		SW (Sweat Lodge)		
		Ingestion/Dermal	Inhalation	(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Inhalation	(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Inhalation
Elm Creek	Antimony	Hematologic, Whole Body	NA	2.2E-03	2.9E-01	8.4E-03	3.7E-01	1.6E-02	NA	ND	NA	NA	NA	NA	NA
	Cadmium	Urinary	Urinary	3.9E-02	4.0E+00	3.5E-01	5.2E+00	6.6E-01	2.7E+01	2.2E-02	2.3E+00	2.0E-01	2.9E+00	3.7E-01	1.5E+01
	Nickel	Whole Body	Respiratory	1.9E-02	4.9E-02	1.1E-03	6.3E-02	2.0E-03	1.4E+00	2.2E-02	5.7E-02	1.3E-03	7.3E-02	2.3E-03	1.7E+00
	Zinc	Immune, Hematologic	NA	6.7E+00	1.2E+00	3.1E-03	1.5E+00	5.7E-03	NA	3.5E+00	6.0E-01	1.6E-03	7.7E-01	2.9E-03	NA
	Exposure Route Total				6	0.4	7	0.7	28		3	0.2	3.7	0.4	17
	Exposure Scenario Total					6			36			3			21
	Total								42						24
	Target Organ-Specific HI			Total Hematologic HI =					3	Total Hematologic HI =					1
				Total Immune HI =					3	Total Immune HI =					1
				Total Respiratory HI =					1	Total Respiratory HI =					2
				Total Urinary HI =					37	Total Urinary HI =					21
				Total Whole Body HI =					0.8	Total Whole Body HI =					0.1
Tar Creek	Arsenic	Cardiovascular, Dermal	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	3.4E-02	5.9E+00	2.6E-02	7.5E+00	4.8E-02	1.6E+01	2.2E-02	3.8E+00	1.7E-02	4.8E+00	3.1E-02	1.0E+01
	Cadmium	Urinary	Urinary	1.6E-02	1.7E+00	1.5E-01	2.2E+00	2.8E-01	1.1E+01	1.5E-02	1.6E+00	1.4E-01	2.1E+00	2.6E-01	1.1E+01
	Cobalt	Endocrine	Respiratory	3.2E-02	5.5E+00	9.7E-03	7.0E+00	1.8E-02	3.6E+01	3.2E-02	5.5E+00	9.7E-03	7.1E+00	1.8E-02	3.7E+01
	Iron	Gastrointestinal	NA	5.1E+01	3.8E+00	1.7E-02	4.9E+00	3.1E-02	NA	3.9E+01	2.9E+00	1.3E-02	3.7E+00	2.4E-02	NA
	Manganese	Nervous	Nervous	1.6E+00	3.5E+00	3.9E-01	4.5E+00	7.2E-01	2.2E+02	1.6E+00	3.5E+00	3.8E-01	4.5E+00	7.1E-01	2.2E+02
	Nickel	Whole Body	Respiratory	3.3E-01	8.7E-01	1.9E-02	1.1E+00	3.5E-02	2.6E+01	2.9E-01	7.4E-01	1.6E-02	9.5E-01	3.0E-02	2.2E+01
	Zinc	Immune, Hematologic	NA	6.3E+00	1.1E+00	2.9E-03	1.4E+00	5.3E-03	NA	6.2E+00	1.1E+00	2.8E-03	1.4E+00	5.2E-03	NA
	Exposure Route Total				22	0.6	29	1	313		19	0.6	25	1	302
	Exposure Scenario Total					23			342			20			327
	Total								365						347
	Target Organ-Specific HI			Total Cardiovascular HI =					29	Total Cardiovascular HI =					19
				Total Dermal HI =					29	Total Dermal HI =					19
				Total Endocrine HI =					13	Total Endocrine HI =					13
				Total Gastrointestinal HI =					9	Total Gastrointestinal HI =					7
				Total Immune HI =					2	Total Immune HI =					2
				Total Hematologic HI =					2	Total Hematologic HI =					2
				Total Nervous HI =					248	Total Nervous HI =					241
				Total Reproductive, Developmental HI =					16	Total Reproductive, Developmental HI =					10
				Total Respiratory HI =					78	Total Respiratory HI =					69
				Total Urinary HI =					16	Total Urinary HI =					15
				Total Whole Body HI =					2	Total Whole Body HI =					2
Beaver Creek	Cadmium	Urinary	Urinary	1.8E-03	1.9E-01	1.6E-02	2.4E-01	3.0E-02	1.2E+00	1.2E-03	1.2E-01	1.1E-02	1.6E-01	2.0E-02	8.1E-01
	Nickel	Whole Body	Respiratory	1.5E-02	3.8E-02	8.3E-04	4.8E-02	1.5E-03	1.1E+00	1.5E-02	3.9E-02	8.7E-04	5.0E-02	1.6E-03	1.2E+00
	Exposure Route Total				0.2	0.02	0.3	0.03	2		0.2	0.01	0.2	0.02	2
	Exposure Scenario Total					0.2			3			0.2			2
	Total								3						2
	Target Organ-Specific HI			Total Respiratory HI =					1	Total Respiratory HI =					1
				Total Urinary HI =					2	Total Urinary HI =					1
				Total Whole Body HI =					0.09	Total Whole Body HI =					0.09

Appendix F2, Table 2. Comparison of Cancer Risk Estimates between Total Metal and Dissolved Metal Data

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Surface Water COC	Cancer Risk											
		Total Metal						Dissolved Metal					
		EPC	SW (Potable Use)		SW (Sweat Lodge)			EPC	SW (Potable Use)		SW (Sweat Lodge)		
		(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Inhalation	(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Inhalation
Tar Creek	Arsenic	3.4E-02	2E-03	1E-05	9E-04	1E-05	1E-03	2.2E-02	1E-03	7E-06	6E-04	9E-06	6E-04
	Cadmium	1.6E-02	NA	NA	NA	NA	2E-04	1.5E-02	NA	NA	NA	NA	2E-04
	Cobalt	3.2E-02	NA	NA	NA	NA	2E-03	3.2E-02	NA	NA	NA	NA	2E-03
	Exposure Route Total		2.E-03	1.E-05	9.E-04	1.E-05	3.E-03		1.E-03	7.E-06	6.E-04	9.E-06	3.E-03
	Exposure Scenario Total			2.E-03			4.E-03			1.E-03			3.E-03
	Total						6.E-03						5.E-03

Appendix F2, Table 3. ProUCL Output - Elm Creek Surface Water (Dissolved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/29/2019 2:20:17 PM
From File	Tar Creek OU5 RI Surface Water Dissolved Metals ProUCL Input.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony, dissolved (mg/L)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	3
Number of Detects	0	Number of Non-Detects	8
Number of Distinct Detects	0	Number of Distinct Non-Detects	3

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Antimony, dissolved (mg/L) was not processed!

Cadmium, dissolved (mg/L)

General Statistics

Total Number of Observations	38	Number of Distinct Observations	21
Number of Detects	19	Number of Non-Detects	19
Number of Distinct Detects	19	Number of Distinct Non-Detects	2
Minimum Detect	6.0000E-5	Minimum Non-Detect	0.001
Maximum Detect	0.0876	Maximum Non-Detect	0.005
Variance Detects	5.8557E-4	Percent Non-Detects	50%
Mean Detects	0.0162	SD Detects	0.0242
Median Detects	0.0059	CV Detects	1.49
Skewness Detects	2.036	Kurtosis Detects	3.554
Mean of Logged Detects	-5.13	SD of Logged Detects	1.662

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.661	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.365	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0083	KM Standard Error of Mean	0.00308
KM SD	0.0185	95% KM (BCA) UCL	0.0138
95% KM (t) UCL	0.0135	95% KM (Percentile Bootstrap) UCL	0.0137
95% KM (z) UCL	0.0134	95% KM Bootstrap t UCL	0.0167
90% KM Chebyshev UCL	0.0175	95% KM Chebyshev UCL	0.0217
97.5% KM Chebyshev UCL	0.0275	99% KM Chebyshev UCL	0.0389

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.91	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.792	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.247	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.208	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.61	k star (bias corrected MLE)	0.549
Theta hat (MLE)	0.0266	Theta star (bias corrected MLE)	0.0296
nu hat (MLE)	23.19	nu star (bias corrected)	20.87
Mean (detects)	0.0162		

Appendix F2, Table 3. ProUCL Output - Elm Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	6.0000E-5	Mean	0.0131
Maximum	0.0876	Median	0.01
SD	0.0172	CV	1.309
k hat (MLE)	1.072	k star (bias corrected MLE)	1.005
Theta hat (MLE)	0.0122	Theta star (bias corrected MLE)	0.0131
nu hat (MLE)	81.5	nu star (bias corrected)	76.4
Adjusted Level of Significance (β)	0.0434		
Approximate Chi Square Value (76.40, α)	57.26	Adjusted Chi Square Value (76.40, β)	56.58
95% Gamma Approximate UCL (use when n>=50)	0.0175	95% Gamma Adjusted UCL (use when n<50)	0.0177

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0083	SD (KM)	0.0185
Variance (KM)	3.4090E-4	SE of Mean (KM)	0.00308
k hat (KM)	0.202	k star (KM)	0.204
nu hat (KM)	15.36	nu star (KM)	15.48
theta hat (KM)	0.0411	theta star (KM)	0.0407
80% gamma percentile (KM)	0.011	90% gamma percentile (KM)	0.0251
95% gamma percentile (KM)	0.0426	99% gamma percentile (KM)	0.0905

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (15.48, α)	7.6	Adjusted Chi Square Value (15.48, β)	7.371
95% Gamma Approximate KM-UCL (use when n>=50)	0.0169	95% Gamma Adjusted KM-UCL (use when n<50)	0.0174

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.916	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.172	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.00831	Mean in Log Scale	-6.852
SD in Original Scale	0.0187	SD in Log Scale	2.294
95% t UCL (assumes normality of ROS data)	0.0134	95% Percentile Bootstrap UCL	0.0135
95% BCA Bootstrap UCL	0.0158	95% Bootstrap t UCL	0.0181
95% H-UCL (Log ROS)	0.0712		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.228	KM Geo Mean	7.2599E-4
KM SD (logged)	2.528	95% Critical H Value (KM-Log)	4.544
KM Standard Error of Mean (logged)	0.442	95% H-UCL (KM -Log)	0.117
KM SD (logged)	2.528	95% Critical H Value (KM-Log)	4.544
KM Standard Error of Mean (logged)	0.442		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00869	Mean in Log Scale	-6.111
SD in Original Scale	0.0185	SD in Log Scale	1.619
95% t UCL (Assumes normality)	0.0138	95% H-Stat UCL	0.0192

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.0217

Appendix F2, Table 3. ProUCL Output - Elm Creek Surface Water (Dissolved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel, dissolved (mg/L)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	9
Number of Detects	7	Number of Non-Detects	7
Number of Distinct Detects	7	Number of Distinct Non-Detects	2
Minimum Detect	0.0074	Minimum Non-Detect	0.02
Maximum Detect	0.0468	Maximum Non-Detect	0.04
Variance Detects	1.7965E-4	Percent Non-Detects	50%
Mean Detects	0.0194	SD Detects	0.0134
Median Detects	0.0166	CV Detects	0.691
Skewness Detects	1.725	Kurtosis Detects	3.252
Mean of Logged Detects	-4.116	SD of Logged Detects	0.616

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.285	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0165	KM Standard Error of Mean	0.00315
KM SD	0.00985	95% KM (BCA) UCL	0.0219
95% KM (t) UCL	0.022	95% KM (Percentile Bootstrap) UCL	0.0216
95% KM (z) UCL	0.0216	95% KM Bootstrap t UCL	0.0242
90% KM Chebyshev UCL	0.0259	95% KM Chebyshev UCL	0.0302
97.5% KM Chebyshev UCL	0.0361	99% KM Chebyshev UCL	0.0478

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.301	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.712	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.227	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.314	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.057	k star (bias corrected MLE)	1.842
Theta hat (MLE)	0.00634	Theta star (bias corrected MLE)	0.0105
nu hat (MLE)	42.8	nu star (bias corrected)	25.79
Mean (detects)	0.0194		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0074	Mean	0.0169
Maximum	0.0468	Median	0.0149
SD	0.01	CV	0.593
k hat (MLE)	4.339	k star (bias corrected MLE)	3.457
Theta hat (MLE)	0.0039	Theta star (bias corrected MLE)	0.00489
nu hat (MLE)	121.5	nu star (bias corrected)	96.78
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (96.78, α)	75.09	Adjusted Chi Square Value (96.78, β)	72.56
95% Gamma Approximate UCL (use when n>=50)	0.0218	95% Gamma Adjusted UCL (use when n<50)	0.0225

Appendix F2, Table 3. ProUCL Output - Elm Creek Surface Water (Dissolved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0165	SD (KM)	0.00985
Variance (KM)	9.6988E-5	SE of Mean (KM)	0.00315
k hat (KM)	2.794	k star (KM)	2.243
nu hat (KM)	78.25	nu star (KM)	62.81
theta hat (KM)	0.00589	theta star (KM)	0.00734
80% gamma percentile (KM)	0.0243	90% gamma percentile (KM)	0.0312
95% gamma percentile (KM)	0.0377	99% gamma percentile (KM)	0.052

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (62.81, α)	45.58	Adjusted Chi Square Value (62.81, β)	43.64
95% Gamma Approximate KM-UCL (use when n>=50)	0.0227	95% Gamma Adjusted KM-UCL (use when n<50)	0.0237

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0164	Mean in Log Scale	-4.238
SD in Original Scale	0.0101	SD in Log Scale	0.497
95% t UCL (assumes normality of ROS data)	0.0212	95% Percentile Bootstrap UCL	0.0211
95% BCA Bootstrap UCL	0.0227	95% Bootstrap t UCL	0.0251
95% H-UCL (Log ROS)	0.0215		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.241	KM Geo Mean	0.0144
KM SD (logged)	0.495	95% Critical H Value (KM-Log)	2.008
KM Standard Error of Mean (logged)	0.179	95% H-UCL (KM -Log)	0.0214
KM SD (logged)	0.495	95% Critical H Value (KM-Log)	2.008
KM Standard Error of Mean (logged)	0.179		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0175	Mean in Log Scale	-4.162
SD in Original Scale	0.00999	SD in Log Scale	0.491
95% t UCL (Assumes normality)	0.0223	95% H-Stat UCL	0.0231

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.022

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc, dissolved (mg/L)

General Statistics

Total Number of Observations	37	Number of Distinct Observations	35
Number of Detects	36	Number of Non-Detects	1
Number of Distinct Detects	35	Number of Distinct Non-Detects	1
Minimum Detect	0.018	Minimum Non-Detect	0.02
Maximum Detect	10.2	Maximum Non-Detect	0.02
Variance Detects	8.46	Percent Non-Detects	2.703%
Mean Detects	2.389	SD Detects	2.909
Median Detects	0.787	CV Detects	1.217
Skewness Detects	1.285	Kurtosis Detects	0.78
Mean of Logged Detects	-0.438	SD of Logged Detects	2.075

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.798	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.935	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.224	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.145	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.325	KM Standard Error of Mean	0.476
KM SD	2.855	95% KM (BCA) UCL	3.174
95% KM (t) UCL	3.129	95% KM (Percentile Bootstrap) UCL	3.138
95% KM (z) UCL	3.108	95% KM Bootstrap t UCL	3.283
90% KM Chebyshev UCL	3.753	95% KM Chebyshev UCL	4.4
97.5% KM Chebyshev UCL	5.298	99% KM Chebyshev UCL	7.062

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.653	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.815	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.113	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.155	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.487	k star (bias corrected MLE)	0.465
Theta hat (MLE)	4.904	Theta star (bias corrected MLE)	5.137
nu hat (MLE)	35.08	nu star (bias corrected)	33.49
Mean (detects)	2.389		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.018	Mean	2.328
Maximum	10.2	Median	0.663
SD	2.892	CV	1.243
k hat (MLE)	0.48	k star (bias corrected MLE)	0.459
Theta hat (MLE)	4.849	Theta star (bias corrected MLE)	5.07
nu hat (MLE)	35.52	nu star (bias corrected)	33.98
Adjusted Level of Significance (β)	0.0431		
Approximate Chi Square Value (33.98, α)	21.64	Adjusted Chi Square Value (33.98, β)	21.22
95% Gamma Approximate UCL (use when n>=50)	3.654	95% Gamma Adjusted UCL (use when n<50)	3.728

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.325	SD (KM)	2.855
Variance (KM)	8.151	SE of Mean (KM)	0.476
k hat (KM)	0.663	k star (KM)	0.628
nu hat (KM)	49.09	nu star (KM)	46.44
theta hat (KM)	3.505	theta star (KM)	3.705
80% gamma percentile (KM)	3.832	90% gamma percentile (KM)	5.987
95% gamma percentile (KM)	8.233	99% gamma percentile (KM)	13.64

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (46.44, α)	31.81	Adjusted Chi Square Value (46.44, β)	31.28
95% Gamma Approximate KM-UCL (use when n>=50)	3.395	95% Gamma Adjusted KM-UCL (use when n<50)	3.453

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.935	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.145	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Appendix F2, Table 3. ProUCL Output - Elm Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.325	Mean in Log Scale	-0.544
SD in Original Scale	2.894	SD in Log Scale	2.146
95% t UCL (assumes normality of ROS data)	3.129	95% Percentile Bootstrap UCL	3.093
95% BCA Bootstrap UCL	3.186	95% Bootstrap t UCL	3.29
95% H-UCL (Log ROS)	23.82		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.535	KM Geo Mean	0.586
KM SD (logged)	2.1	95% Critical H Value (KM-Log)	3.878
KM Standard Error of Mean (logged)	0.35	95% H-UCL (KM -Log)	20.67
KM SD (logged)	2.1	95% Critical H Value (KM-Log)	3.878
KM Standard Error of Mean (logged)	0.35		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.325	Mean in Log Scale	-0.551
SD in Original Scale	2.895	SD in Log Scale	2.158
95% t UCL (Assumes normality)	3.129	95% H-Stat UCL	24.62

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1) 3.453

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/29/2019 2:22:14 PM
From File	Tar Creek OU5 RI Surface Water Dissolved Metals ProUCL Input_a.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Arsenic, dissolved (mg/L)

General Statistics

Total Number of Observations	320	Number of Distinct Observations	115
Number of Detects	152	Number of Non-Detects	168
Number of Distinct Detects	113	Number of Distinct Non-Detects	3
Minimum Detect	3.0000E-4	Minimum Non-Detect	0.003
Maximum Detect	0.085	Maximum Non-Detect	0.01
Variance Detects	7.5583E-4	Percent Non-Detects	52.5%
Mean Detects	0.0317	SD Detects	0.0275
Median Detects	0.0351	CV Detects	0.866
Skewness Detects	0.125	Kurtosis Detects	-1.56
Mean of Logged Detects	-4.459	SD of Logged Detects	1.855

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.835	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0723	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0158	KM Standard Error of Mean	0.00136
KM SD	0.0242	95% KM (BCA) UCL	0.018
95% KM (t) UCL	0.0181	95% KM (Percentile Bootstrap) UCL	0.018
95% KM (z) UCL	0.0181	95% KM Bootstrap t UCL	0.0181
90% KM Chebyshev UCL	0.0199	95% KM Chebyshev UCL	0.0218
97.5% KM Chebyshev UCL	0.0243	99% KM Chebyshev UCL	0.0294

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	10.7	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.809	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.207	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.0798	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.611	k star (bias corrected MLE)	0.603
Theta hat (MLE)	0.052	Theta star (bias corrected MLE)	0.0526
nu hat (MLE)	185.7	nu star (bias corrected)	183.3
Mean (detects)	0.0317		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum	3.0000E-4	Mean	0.0213
Maximum	0.085	Median	0.01
SD	0.0215	CV	1.009
k hat (MLE)	0.948	k star (bias corrected MLE)	0.941
Theta hat (MLE)	0.0225	Theta star (bias corrected MLE)	0.0226
nu hat (MLE)	606.7	nu star (bias corrected)	602.3
Adjusted Level of Significance (β)	0.0493		
Approximate Chi Square Value (602.31, α)	546.4	Adjusted Chi Square Value (602.31, β)	546.1
95% Gamma Approximate UCL (use when n>=50)	0.0235	95% Gamma Adjusted UCL (use when n<50)	0.0235

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0158	SD (KM)	0.0242
Variance (KM)	5.8673E-4	SE of Mean (KM)	0.00136
k hat (KM)	0.427	k star (KM)	0.425
nu hat (KM)	273.2	nu star (KM)	271.9
theta hat (KM)	0.0371	theta star (KM)	0.0372
80% gamma percentile (KM)	0.0257	90% gamma percentile (KM)	0.0442
95% gamma percentile (KM)	0.0644	99% gamma percentile (KM)	0.115

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (271.93, α)	234.7	Adjusted Chi Square Value (271.93, β)	234.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.0183	95% Gamma Adjusted KM-UCL (use when n<50)	0.0183

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.785	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.245	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0723	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0167	Mean in Log Scale	-5.44
SD in Original Scale	0.0238	SD in Log Scale	1.801
95% t UCL (assumes normality of ROS data)	0.0189	95% Percentile Bootstrap UCL	0.019
95% BCA Bootstrap UCL	0.019	95% Bootstrap t UCL	0.019
95% H-UCL (Log ROS)	0.0294		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.687	KM Geo Mean	0.00339
KM SD (logged)	1.787	95% Critical H Value (KM-Log)	2.865
KM Standard Error of Mean (logged)	0.11	95% H-UCL (KM -Log)	0.0223
KM SD (logged)	1.787	95% Critical H Value (KM-Log)	2.865
KM Standard Error of Mean (logged)	0.11		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0173	Mean in Log Scale	-5.027
SD in Original Scale	0.0234	SD in Log Scale	1.428
95% t UCL (Assumes normality)	0.0195	95% H-Stat UCL	0.0222

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.0218

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Cadmium, dissolved (mg/L)

General Statistics

Total Number of Observations	538	Number of Distinct Observations	309
Number of Detects	406	Number of Non-Detects	132
Number of Distinct Detects	309	Number of Distinct Non-Detects	4
Minimum Detect	6.0000E-5	Minimum Non-Detect	1.0000E-4
Maximum Detect	0.195	Maximum Non-Detect	0.005
Variance Detects	4.8628E-4	Percent Non-Detects	24.54%
Mean Detects	0.015	SD Detects	0.0221
Median Detects	0.00896	CV Detects	1.47
Skewness Detects	4.075	Kurtosis Detects	21.98
Mean of Logged Detects	-4.958	SD of Logged Detects	1.41

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.598	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.249	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0443	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0116	KM Standard Error of Mean	8.6633E-4
KM SD	0.0201	95% KM (BCA) UCL	0.0131
95% KM (t) UCL	0.013	95% KM (Percentile Bootstrap) UCL	0.013
95% KM (z) UCL	0.013	95% KM Bootstrap t UCL	0.0132
90% KM Chebyshev UCL	0.0142	95% KM Chebyshev UCL	0.0154
97.5% KM Chebyshev UCL	0.017	99% KM Chebyshev UCL	0.0202

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.054	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.796	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0845	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.0466	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.784	k star (bias corrected MLE)	0.78
Theta hat (MLE)	0.0191	Theta star (bias corrected MLE)	0.0192
nu hat (MLE)	636.6	nu star (bias corrected)	633.3
Mean (detects)	0.015		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	6.0000E-5	Mean	0.0138
Maximum	0.195	Median	0.01
SD	0.0193	CV	1.399
k hat (MLE)	0.985	k star (bias corrected MLE)	0.981
Theta hat (MLE)	0.014	Theta star (bias corrected MLE)	0.014
nu hat (MLE)	1060	nu star (bias corrected)	1055
Adjusted Level of Significance (β)	0.0496		
Approximate Chi Square Value (N/A, α)	981	Adjusted Chi Square Value (N/A, β)	980.8
95% Gamma Approximate UCL (use when n>=50)	0.0148	95% Gamma Adjusted UCL (use when n<50)	0.0148

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0116	SD (KM)	0.0201
Variance (KM)	4.0223E-4	SE of Mean (KM)	8.6633E-4
k hat (KM)	0.335	k star (KM)	0.334
nu hat (KM)	359.9	nu star (KM)	359.3
theta hat (KM)	0.0347	theta star (KM)	0.0347
80% gamma percentile (KM)	0.0182	90% gamma percentile (KM)	0.0337
95% gamma percentile (KM)	0.0512	99% gamma percentile (KM)	0.0962

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (359.27, α)	316.3	Adjusted Chi Square Value (359.27, β)	316.2
95% Gamma Approximate KM-UCL (use when n>=50)	0.0132	95% Gamma Adjusted KM-UCL (use when n<50)	0.0132

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.941	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.107	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0443	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0116	Mean in Log Scale	-5.521
SD in Original Scale	0.0201	SD in Log Scale	1.651
95% t UCL (assumes normality of ROS data)	0.013	95% Percentile Bootstrap UCL	0.013
95% BCA Bootstrap UCL	0.0133	95% Bootstrap t UCL	0.0133
95% H-UCL (Log ROS)	0.019		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-5.661	KM Geo Mean	0.00348
KM SD (logged)	1.898	95% Critical H Value (KM-Log)	2.97
KM Standard Error of Mean (logged)	0.0897	95% H-UCL (KM -Log)	0.0269
KM SD (logged)	1.898	95% Critical H Value (KM-Log)	2.97
KM Standard Error of Mean (logged)	0.0897		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0118	Mean in Log Scale	-5.415
SD in Original Scale	0.02	SD in Log Scale	1.586
95% t UCL (Assumes normality)	0.0132	95% H-Stat UCL	0.0188

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.0154

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cobalt, dissolved (mg/L)

General Statistics

Total Number of Observations	367	Number of Distinct Observations	209
Number of Detects	254	Number of Non-Detects	113
Number of Distinct Detects	207	Number of Distinct Non-Detects	5
Minimum Detect	8.0000E-4	Minimum Non-Detect	6.0000E-4
Maximum Detect	0.0968	Maximum Non-Detect	0.1
Variance Detects	6.6284E-4	Percent Non-Detects	30.79%
Mean Detects	0.0321	SD Detects	0.0257
Median Detects	0.0217	CV Detects	0.801
Skewness Detects	0.535	Kurtosis Detects	-1.03
Mean of Logged Detects	-3.897	SD of Logged Detects	1.086

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.871	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.167	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.056	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0261	KM Standard Error of Mean	0.00133
KM SD	0.0243	95% KM (BCA) UCL	0.0281
95% KM (t) UCL	0.0283	95% KM (Percentile Bootstrap) UCL	0.0283
95% KM (z) UCL	0.0283	95% KM Bootstrap t UCL	0.0283
90% KM Chebyshev UCL	0.0301	95% KM Chebyshev UCL	0.0319
97.5% KM Chebyshev UCL	0.0344	99% KM Chebyshev UCL	0.0393

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.053	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.778	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.129	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0588	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.229	k star (bias corrected MLE)	1.217
Theta hat (MLE)	0.0261	Theta star (bias corrected MLE)	0.0264
nu hat (MLE)	624.5	nu star (bias corrected)	618.4
Mean (detects)	0.0321		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	8.0000E-4	Mean	0.0273
Maximum	0.0968	Median	0.017
SD	0.0231	CV	0.847
k hat (MLE)	1.406	k star (bias corrected MLE)	1.396
Theta hat (MLE)	0.0194	Theta star (bias corrected MLE)	0.0195
nu hat (MLE)	1032	nu star (bias corrected)	1025
Adjusted Level of Significance (β)	0.0493		
Approximate Chi Square Value (N/A, α)	951.6	Adjusted Chi Square Value (N/A, β)	951.3
95% Gamma Approximate UCL (use when n>=50)	0.0294	95% Gamma Adjusted UCL (use when n<50)	0.0294

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0261	SD (KM)	0.0243
Variance (KM)	5.9013E-4	SE of Mean (KM)	0.00133
k hat (KM)	1.151	k star (KM)	1.144
nu hat (KM)	845	nu star (KM)	839.5
theta hat (KM)	0.0226	theta star (KM)	0.0228
80% gamma percentile (KM)	0.0415	90% gamma percentile (KM)	0.0581
95% gamma percentile (KM)	0.0745	99% gamma percentile (KM)	0.112

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (839.46, α)	773.2	Adjusted Chi Square Value (839.46, β)	773
95% Gamma Approximate KM-UCL (use when n>=50)	0.0283	95% Gamma Adjusted KM-UCL (use when n<50)	0.0283

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.915	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.128	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.056	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0256	Mean in Log Scale	-4.191
SD in Original Scale	0.024	SD in Log Scale	1.12
95% t UCL (assumes normality of ROS data)	0.0277	95% Percentile Bootstrap UCL	0.0276
95% BCA Bootstrap UCL	0.0279	95% Bootstrap t UCL	0.0278
95% H-UCL (Log ROS)	0.0322		

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.21	KM Geo Mean	0.0148
KM SD (logged)	1.181	95% Critical H Value (KM-Log)	2.281
KM Standard Error of Mean (logged)	0.0704	95% H-UCL (KM -Log)	0.0343
KM SD (logged)	1.181	95% Critical H Value (KM-Log)	2.281
KM Standard Error of Mean (logged)	0.0704		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0287	Mean in Log Scale	-3.977
SD in Original Scale	0.0228	SD in Log Scale	1.064
95% t UCL (Assumes normality)	0.0307	95% H-Stat UCL	0.0373

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.0319

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron, dissolved (mg/L)

General Statistics

Total Number of Observations	540	Number of Distinct Observations	394
Number of Detects	487	Number of Non-Detects	53
Number of Distinct Detects	391	Number of Distinct Non-Detects	6
Minimum Detect	0.00468	Minimum Non-Detect	0.003
Maximum Detect	216	Maximum Non-Detect	0.1
Variance Detects	3466	Percent Non-Detects	9.815%
Mean Detects	31.58	SD Detects	58.88
Median Detects	1.15	CV Detects	1.865
Skewness Detects	1.748	Kurtosis Detects	1.437
Mean of Logged Detects	0.402	SD of Logged Detects	3.045

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.573	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.354	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0405	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	28.48	KM Standard Error of Mean	2.44
KM SD	56.64	95% KM (BCA) UCL	32.24
95% KM (t) UCL	32.5	95% KM (Percentile Bootstrap) UCL	32.63
95% KM (z) UCL	32.49	95% KM Bootstrap t UCL	32.75
90% KM Chebyshev UCL	35.8	95% KM Chebyshev UCL	39.11
97.5% KM Chebyshev UCL	43.72	99% KM Chebyshev UCL	52.75

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	24.1	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.904	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.152	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.0452	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.235	k star (bias corrected MLE)	0.235
Theta hat (MLE)	134.3	Theta star (bias corrected MLE)	134.3
nu hat (MLE)	229	nu star (bias corrected)	228.9
Mean (detects)	31.58		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00468	Mean	28.8
Maximum	216	Median	2.295
SD	56.54	CV	1.963
k hat (MLE)	0.247	k star (bias corrected MLE)	0.247
Theta hat (MLE)	116.6	Theta star (bias corrected MLE)	116.6
nu hat (MLE)	266.8	nu star (bias corrected)	266.7
Adjusted Level of Significance (β)	0.0496		
Approximate Chi Square Value (266.68, α)	229.9	Adjusted Chi Square Value (266.68, β)	229.8
95% Gamma Approximate UCL (use when n>=50)	33.42	95% Gamma Adjusted UCL (use when n<50)	33.43

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	28.48	SD (KM)	56.64
Variance (KM)	3208	SE of Mean (KM)	2.44
k hat (KM)	0.253	k star (KM)	0.253
nu hat (KM)	273	nu star (KM)	272.9
theta hat (KM)	112.6	theta star (KM)	112.7
80% gamma percentile (KM)	41.51	90% gamma percentile (KM)	85.42
95% gamma percentile (KM)	137.4	99% gamma percentile (KM)	275.6

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (272.86, α)	235.6	Adjusted Chi Square Value (272.86, β)	235.5
95% Gamma Approximate KM-UCL (use when n>=50)	32.98	95% Gamma Adjusted KM-UCL (use when n<50)	32.99

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.907	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0974	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0405	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	28.48	Mean in Log Scale	-0.177
SD in Original Scale	56.69	SD in Log Scale	3.425
95% t UCL (assumes normality of ROS data)	32.5	95% Percentile Bootstrap UCL	32.25
95% BCA Bootstrap UCL	32.83	95% Bootstrap t UCL	32.87
95% H-UCL (Log ROS)	593.4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.0803	KM Geo Mean	0.923
KM SD (logged)	3.249	95% Critical H Value (KM-Log)	4.506
KM Standard Error of Mean (logged)	0.141	95% H-UCL (KM -Log)	339.4
KM SD (logged)	3.249	95% Critical H Value (KM-Log)	4.506
KM Standard Error of Mean (logged)	0.141		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	28.48	Mean in Log Scale	-0.0475
SD in Original Scale	56.69	SD in Log Scale	3.207
95% t UCL (Assumes normality)	32.5	95% H-Stat UCL	302

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% KM (Chebyshev) UCL 39.11

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese, dissolved (mg/L)

General Statistics

Total Number of Observations	523	Number of Distinct Observations	399
Number of Detects	520	Number of Non-Detects	3
Number of Distinct Detects	396	Number of Distinct Non-Detects	3
Minimum Detect	0.0083	Minimum Non-Detect	0.015
Maximum Detect	7.08	Maximum Non-Detect	0.05
Variance Detects	1.893	Percent Non-Detects	0.574%
Mean Detects	1.354	SD Detects	1.376
Median Detects	0.896	CV Detects	1.016
Skewness Detects	1.914	Kurtosis Detects	3.446
Mean of Logged Detects	-0.154	SD of Logged Detects	1.014

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.756	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.211	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0392	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.346	KM Standard Error of Mean	0.0602
KM SD	1.375	95% KM (BCA) UCL	1.445
95% KM (t) UCL	1.445	95% KM (Percentile Bootstrap) UCL	1.444
95% KM (z) UCL	1.445	95% KM Bootstrap t UCL	1.445
90% KM Chebyshev UCL	1.527	95% KM Chebyshev UCL	1.608
97.5% KM Chebyshev UCL	1.722	99% KM Chebyshev UCL	1.945

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.72	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.779	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0927	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.041	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.234	k star (bias corrected MLE)	1.228
Theta hat (MLE)	1.098	Theta star (bias corrected MLE)	1.103
nu hat (MLE)	1283	nu star (bias corrected)	1277
Mean (detects)	1.354		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0083	Mean	1.346
Maximum	7.08	Median	0.891
SD	1.376	CV	1.022
k hat (MLE)	1.187	k star (bias corrected MLE)	1.182
Theta hat (MLE)	1.134	Theta star (bias corrected MLE)	1.139
nu hat (MLE)	1242	nu star (bias corrected)	1236
Adjusted Level of Significance (β)	0.0495		
Approximate Chi Square Value (N/A, α)	1155	Adjusted Chi Square Value (N/A, β)	1155
95% Gamma Approximate UCL (use when n>=50)	1.44	95% Gamma Adjusted UCL (use when n<50)	1.44

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.346	SD (KM)	1.375
Variance (KM)	1.889	SE of Mean (KM)	0.0602
k hat (KM)	0.959	k star (KM)	0.955
nu hat (KM)	1003	nu star (KM)	999
theta hat (KM)	1.403	theta star (KM)	1.41
80% gamma percentile (KM)	2.175	90% gamma percentile (KM)	3.135
95% gamma percentile (KM)	4.099	99% gamma percentile (KM)	6.345

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (998.97, α)	926.6	Adjusted Chi Square Value (998.97, β)	926.4
95% Gamma Approximate KM-UCL (use when n>=50)	1.451	95% Gamma Adjusted KM-UCL (use when n<50)	1.452

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.972	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	3.8083E-5	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0495	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0392	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.347	Mean in Log Scale	-0.17
SD in Original Scale	1.376	SD in Log Scale	1.031
95% t UCL (assumes normality of ROS data)	1.446	95% Percentile Bootstrap UCL	1.443
95% BCA Bootstrap UCL	1.449	95% Bootstrap t UCL	1.452
95% H-UCL (Log ROS)	1.581		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.18	KM Geo Mean	0.835
KM SD (logged)	1.067	95% Critical H Value (KM-Log)	2.166
KM Standard Error of Mean (logged)	0.0467	95% H-UCL (KM -Log)	1.632
KM SD (logged)	1.067	95% Critical H Value (KM-Log)	2.166
KM Standard Error of Mean (logged)	0.0467		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.346	Mean in Log Scale	-0.178
SD in Original Scale	1.376	SD in Log Scale	1.058
95% t UCL (Assumes normality)	1.445	95% H-Stat UCL	1.619

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 1.608

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel, dissolved (mg/L)

General Statistics

Total Number of Observations	478	Number of Distinct Observations	292
Number of Detects	405	Number of Non-Detects	73
Number of Distinct Detects	292	Number of Distinct Non-Detects	5
Minimum Detect	0.00647	Minimum Non-Detect	0.01
Maximum Detect	1.04	Maximum Non-Detect	0.1
Variance Detects	0.0935	Percent Non-Detects	15.27%
Mean Detects	0.264	SD Detects	0.306
Median Detects	0.104	CV Detects	1.158
Skewness Detects	1.207	Kurtosis Detects	0.0351
Mean of Logged Detects	-2.125	SD of Logged Detects	1.366

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.746	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.264	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0444	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.227	KM Standard Error of Mean	0.0135
KM SD	0.295	95% KM (BCA) UCL	0.248
95% KM (t) UCL	0.249	95% KM (Percentile Bootstrap) UCL	0.249
95% KM (z) UCL	0.249	95% KM Bootstrap t UCL	0.25
90% KM Chebyshev UCL	0.267	95% KM Chebyshev UCL	0.286
97.5% KM Chebyshev UCL	0.311	99% KM Chebyshev UCL	0.361

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	10.37	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.797	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.157	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0467	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.754	k star (bias corrected MLE)	0.75
Theta hat (MLE)	0.35	Theta star (bias corrected MLE)	0.352
nu hat (MLE)	610.8	nu star (bias corrected)	607.6
Mean (detects)	0.264		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.00647	Mean	0.227
Maximum	1.04	Median	0.0864
SD	0.295	CV	1.3
k hat (MLE)	0.645	k star (bias corrected MLE)	0.642
Theta hat (MLE)	0.352	Theta star (bias corrected MLE)	0.353
nu hat (MLE)	616.7	nu star (bias corrected)	614.2
Adjusted Level of Significance (β)	0.0495		
Approximate Chi Square Value (614.19, α)	557.7	Adjusted Chi Square Value (614.19, β)	557.5
95% Gamma Approximate UCL (use when n>=50)	0.25	95% Gamma Adjusted UCL (use when n<50)	0.25

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.227	SD (KM)	0.295
Variance (KM)	0.0868	SE of Mean (KM)	0.0135
k hat (KM)	0.592	k star (KM)	0.59
nu hat (KM)	566.1	nu star (KM)	563.9
theta hat (KM)	0.383	theta star (KM)	0.384
80% gamma percentile (KM)	0.374	90% gamma percentile (KM)	0.592
95% gamma percentile (KM)	0.821	99% gamma percentile (KM)	1.375

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (563.93, α)	509.8	Adjusted Chi Square Value (563.93, β)	509.7
95% Gamma Approximate KM-UCL (use when n>=50)	0.251	95% Gamma Adjusted KM-UCL (use when n<50)	0.251

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.928	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0971	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0444	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.227	Mean in Log Scale	-2.435
SD in Original Scale	0.295	SD in Log Scale	1.494
95% t UCL (assumes normality of ROS data)	0.249	95% Percentile Bootstrap UCL	0.25
95% BCA Bootstrap UCL	0.251	95% Bootstrap t UCL	0.249
95% H-UCL (Log ROS)	0.318		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.428	KM Geo Mean	0.0882
KM SD (logged)	1.462	95% Critical H Value (KM-Log)	2.516
KM Standard Error of Mean (logged)	0.0679	95% H-UCL (KM -Log)	0.304
KM SD (logged)	1.462	95% Critical H Value (KM-Log)	2.516
KM Standard Error of Mean (logged)	0.0679		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.227	Mean in Log Scale	-2.405
SD in Original Scale	0.295	SD in Log Scale	1.438
95% t UCL (Assumes normality)	0.249	95% H-Stat UCL	0.299

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.286

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc, dissolved (mg/L)

General Statistics

Total Number of Observations	585	Number of Distinct Observations	463
Number of Detects	580	Number of Non-Detects	5
Number of Distinct Detects	462	Number of Distinct Non-Detects	3
Minimum Detect	0.01	Minimum Non-Detect	0.02
Maximum Detect	61.7	Maximum Non-Detect	0.0812
Variance Detects	38.57	Percent Non-Detects	0.855%
Mean Detects	5.109	SD Detects	6.211
Median Detects	3.9	CV Detects	1.216
Skewness Detects	4.65	Kurtosis Detects	31.77
Mean of Logged Detects	0.895	SD of Logged Detects	1.631

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.629	**Normal GOF Test on Detected Observations Only**	
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0371	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	5.066	KM Standard Error of Mean	0.256
KM SD	6.196	95% KM (BCA) UCL	5.484
95% KM (t) UCL	5.488	95% KM (Percentile Bootstrap) UCL	5.499
95% KM (z) UCL	5.487	95% KM Bootstrap t UCL	5.543
90% KM Chebyshev UCL	5.835	95% KM Chebyshev UCL	6.183
97.5% KM Chebyshev UCL	6.667	99% KM Chebyshev UCL	7.617

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	10.64	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.794	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.107	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.04	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.806	k star (bias corrected MLE)	0.803
Theta hat (MLE)	6.339	Theta star (bias corrected MLE)	6.363
nu hat (MLE)	934.9	nu star (bias corrected)	931.4
Mean (detects)	5.109		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	5.066
Maximum	61.7	Median	3.85
SD	6.202	CV	1.224
k hat (MLE)	0.771	k star (bias corrected MLE)	0.768
Theta hat (MLE)	6.574	Theta star (bias corrected MLE)	6.598
nu hat (MLE)	901.5	nu star (bias corrected)	898.2
Adjusted Level of Significance (β)	0.0496		
Approximate Chi Square Value (898.24, α)	829.7	Adjusted Chi Square Value (898.24, β)	829.5
95% Gamma Approximate UCL (use when n>=50)	5.484	95% Gamma Adjusted UCL (use when n<50)	5.485

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	5.066	SD (KM)	6.196
Variance (KM)	38.4	SE of Mean (KM)	0.256
k hat (KM)	0.668	k star (KM)	0.666
nu hat (KM)	781.9	nu star (KM)	779.3
theta hat (KM)	7.58	theta star (KM)	7.606
80% gamma percentile (KM)	8.339	90% gamma percentile (KM)	12.86
95% gamma percentile (KM)	17.55	99% gamma percentile (KM)	28.8

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (779.26, α)	715.5	Adjusted Chi Square Value (779.26, β)	715.3
95% Gamma Approximate KM-UCL (use when n>=50)	5.517	95% Gamma Adjusted KM-UCL (use when n<50)	5.518

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.826	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0371	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	5.067	Mean in Log Scale	0.869
SD in Original Scale	6.201	SD in Log Scale	1.648
95% t UCL (assumes normality of ROS data)	5.489	95% Percentile Bootstrap UCL	5.498
95% BCA Bootstrap UCL	5.541	95% Bootstrap t UCL	5.573
95% H-UCL (Log ROS)	11.16		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.855	KM Geo Mean	2.35
KM SD (logged)	1.682	95% Critical H Value (KM-Log)	2.751
KM Standard Error of Mean (logged)	0.0696	95% H-UCL (KM -Log)	11.7
KM SD (logged)	1.682	95% Critical H Value (KM-Log)	2.751
KM Standard Error of Mean (logged)	0.0696		

Appendix F2, Table 4. ProUCL Output - Tar Creek Surface Water (Dissolved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	5.066	Mean in Log Scale	0.855
SD in Original Scale	6.202	SD in Log Scale	1.68
95% t UCL (Assumes normality)	5.488	95% H-Stat UCL	11.68

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 6.183

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F2, Table 5. ProUCL Output - Beaver Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.111/13/2019 10:11:45 PM
From File	Tar Creek OU5 RI Surface Water Dissolved Metals ProUCL Input_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Cadmium, dissolved (mg/L)

General Statistics

Total Number of Observations	57	Number of Distinct Observations	17
Number of Detects	21	Number of Non-Detects	36
Number of Distinct Detects	14	Number of Distinct Non-Detects	3
Minimum Detect	1.0000E-4	Minimum Non-Detect	5.0000E-4
Maximum Detect	0.00217	Maximum Non-Detect	0.005
Variance Detects	4.9839E-7	Percent Non-Detects	63.16%
Mean Detects	8.00E-04	SD Detects	7.0597E-4
Median Detects	4.0000E-4	CV Detects	0.882
Skewness Detects	0.657	Kurtosis Detects	-0.955
Mean of Logged Detects	-7.605	SD of Logged Detects	1.053

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.832	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.278	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	6.3574E-4	KM Standard Error of Mean	1.2304E-4
KM SD	6.4487E-4	95% KM (BCA) UCL	8.4680E-4
95% KM (t) UCL	8.4152E-4	95% KM (Percentile Bootstrap) UCL	8.3086E-4
95% KM (z) UCL	8.3812E-4	95% KM Bootstrap t UCL	8.7291E-4
90% KM Chebyshev UCL	0.001	95% KM Chebyshev UCL	0.00117
97.5% KM Chebyshev UCL	0.0014	99% KM Chebyshev UCL	0.00186

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.558	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.765	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.293	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.194	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.194	k star (bias corrected MLE)	1.056
Theta hat (MLE)	6.6980E-4	Theta star (bias corrected MLE)	7.5793E-4
nu hat (MLE)	50.16	nu star (bias corrected)	44.33
Mean (detects)	8.0000E-4		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix F2, Table 5. ProUCL Output - Beaver Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Minimum	1.0000E-4	Mean	0.00661
Maximum	0.01	Median	0.01
SD	0.0045	CV	0.68
k hat (MLE)	0.852	k star (bias corrected MLE)	0.819
Theta hat (MLE)	0.00776	Theta star (bias corrected MLE)	0.00808
nu hat (MLE)	97.1	nu star (bias corrected)	93.32
Adjusted Level of Significance (β)	0.0458		
Approximate Chi Square Value (93.32, α)	72.04	Adjusted Chi Square Value (93.32, β)	71.56
95% Gamma Approximate UCL (use when n>=50)	0.00856	95% Gamma Adjusted UCL (use when n<50)	0.00862

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	6.3574E-4	SD (KM)	6.4487E-4
Variance (KM)	4.1586E-7	SE of Mean (KM)	1.2304E-4
k hat (KM)	0.972	k star (KM)	0.932
nu hat (KM)	110.8	nu star (KM)	106.3
theta hat (KM)	6.5413E-4	theta star (KM)	6.8181E-4
80% gamma percentile (KM)	0.00103	90% gamma percentile (KM)	0.00149
95% gamma percentile (KM)	0.00195	99% gamma percentile (KM)	0.00303

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (106.30, α)	83.5	Adjusted Chi Square Value (106.30, β)	82.98
95% Gamma Approximate KM-UCL (use when n>=50)	8.0927E-4	95% Gamma Adjusted KM-UCL (use when n<50)	8.1437E-4

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.844	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.283	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	6.2633E-4	Mean in Log Scale	-7.823
SD in Original Scale	6.1739E-4	SD in Log Scale	0.963
95% t UCL (assumes normality of ROS data)	7.6310E-4	95% Percentile Bootstrap UCL	7.6577E-4
95% BCA Bootstrap UCL	7.7665E-4	95% Bootstrap t UCL	7.9164E-4
95% H-UCL (Log ROS)	8.5443E-4		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-7.864	KM Geo Mean	3.8447E-4
KM SD (logged)	0.983	95% Critical H Value (KM-Log)	2.317
KM Standard Error of Mean (logged)	0.191	95% H-UCL (KM -Log)	8.4514E-4
KM SD (logged)	0.983	95% Critical H Value (KM-Log)	2.317
KM Standard Error of Mean (logged)	0.191		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.00154	Mean in Log Scale	-6.918
SD in Original Scale	0.00103	SD in Log Scale	1.123
95% t UCL (Assumes normality)	0.00177	95% H-Stat UCL	0.00271

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.00117

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F2, Table 5. ProUCL Output - Beaver Creek Surface Water (Dissolved)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Nickel, dissolved (mg/L)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	16
Number of Detects	16	Number of Non-Detects	46
Number of Distinct Detects	14	Number of Distinct Non-Detects	4
Minimum Detect	0.01	Minimum Non-Detect	0.01
Maximum Detect	0.0351	Maximum Non-Detect	0.05
Variance Detects	5.0353E-5	Percent Non-Detects	74.19%
Mean Detects	0.0188	SD Detects	0.0071
Median Detects	0.0189	CV Detects	0.378
Skewness Detects	0.739	Kurtosis Detects	0.373
Mean of Logged Detects	-4.041	SD of Logged Detects	0.378

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.94	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0135	KM Standard Error of Mean	9.8064E-4
KM SD	0.00606	95% KM (BCA) UCL	0.0152
95% KM (t) UCL	0.0151	95% KM (Percentile Bootstrap) UCL	0.0152
95% KM (z) UCL	0.0151	95% KM Bootstrap t UCL	0.0155
90% KM Chebyshev UCL	0.0164	95% KM Chebyshev UCL	0.0177
97.5% KM Chebyshev UCL	0.0196	99% KM Chebyshev UCL	0.0232

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.239	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.116	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.707	k star (bias corrected MLE)	6.303
Theta hat (MLE)	0.00244	Theta star (bias corrected MLE)	0.00298
nu hat (MLE)	246.6	nu star (bias corrected)	201.7
Mean (detects)	0.0188		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0132
Maximum	0.0351	Median	0.01
SD	0.00577	CV	0.437
k hat (MLE)	7.471	k star (bias corrected MLE)	7.12
Theta hat (MLE)	0.00177	Theta star (bias corrected MLE)	0.00186
nu hat (MLE)	926.4	nu star (bias corrected)	882.9
Adjusted Level of Significance (β)	0.0461		
Approximate Chi Square Value (882.94, α)	815	Adjusted Chi Square Value (882.94, β)	813.4
95% Gamma Approximate UCL (use when n>=50)	0.0143	95% Gamma Adjusted UCL (use when n<50)	0.0144

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0135	SD (KM)	0.00606
Variance (KM)	3.6749E-5	SE of Mean (KM)	9.8064E-4
k hat (KM)	4.938	k star (KM)	4.709
nu hat (KM)	612.3	nu star (KM)	584
theta hat (KM)	0.00273	theta star (KM)	0.00286
80% gamma percentile (KM)	0.0182	90% gamma percentile (KM)	0.0218
95% gamma percentile (KM)	0.025	99% gamma percentile (KM)	0.0319

Appendix F2, Table 5. ProUCL Output - Beaver Creek Surface Water (Dissolved)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (583.96, α)	528.9	Adjusted Chi Square Value (583.96, β)	527.7
95% Gamma Approximate KM-UCL (use when n>=50)	0.0149	95% Gamma Adjusted KM-UCL (use when n<50)	0.0149

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.133	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.011	Mean in Log Scale	-4.719
SD in Original Scale	0.00735	SD in Log Scale	0.651
95% t UCL (assumes normality of ROS data)	0.0125	95% Percentile Bootstrap UCL	0.0126
95% BCA Bootstrap UCL	0.0127	95% Bootstrap t UCL	0.0127
95% H-UCL (Log ROS)	0.013		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-4.382	KM Geo Mean	0.0125
KM SD (logged)	0.358	95% Critical H Value (KM-Log)	1.781
KM Standard Error of Mean (logged)	0.058	95% H-UCL (KM -Log)	0.0145
KM SD (logged)	0.358	95% Critical H Value (KM-Log)	1.781
KM Standard Error of Mean (logged)	0.058		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0153	Mean in Log Scale	-4.414
SD in Original Scale	0.0093	SD in Log Scale	0.735
95% t UCL (Assumes normality)	0.0173	95% H-Stat UCL	0.0192

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0151

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F3, Table 1. Mine Discharge Samples used in the HHRA

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Data Grouping[a]	Location ID	Sample ID	Watershed	Sample Date
OU5_MD_TC	TC MD 01	TC-SW-MD-01	Tar Creek	07/11/17
OU5_MD_TC	TC MD 01	TC-SW-MD-02	Tar Creek	10/26/17
OU5_MD_TC	TC MD 02	TC-SW-MD-03	Tar Creek	10/26/17
OU5_MD_TC	TC MD 03	TC-SW-MD-04	Tar Creek	10/26/17
OU5_MD_TC	TC MD 04	TC-SW-MD-05	Tar Creek	10/30/17
OU5_MD_BC	BC-MD1	BC-MD1_20070406	Beaver Creek	04/06/07
OU5_MD_BC	BC-MD1	BC-MD1_20070504	Beaver Creek	05/04/07
OU5_MD_BC	BC-MD1E	BC-MD1E_20070601	Beaver Creek	06/01/07
OU5_MD_BC	BC-MD1	BC-MD1_20070601	Beaver Creek	06/01/07
OU5_MD_BC	BC-MD1	BC-MD1_20070706	Beaver Creek	07/06/07
OU5_MD_BC	BC-MD1	BC-MD1_20070803	Beaver Creek	08/03/07
OU5_MD_BC	BC-MD1	BC-MD1_20070907	Beaver Creek	09/07/07
OU5_MD_BC	BC-MD1	BC-MD1_20071005	Beaver Creek	10/05/07
OU5_MD_BC	BC-MD1	BC-MD1_20071102	Beaver Creek	11/02/07
OU5_MD_BC	BC-MD1	BC-MD1_20080108	Beaver Creek	01/08/08
OU5_MD_BC	BC-MD1	BC-MD1_20080201	Beaver Creek	02/01/08
OU5_MD_BC	BC-MD1	BC-MD1_20080307	Beaver Creek	03/07/08
OU5_MD_BC	BC-MD1	BC-MD1_20080404	Beaver Creek	04/04/08
OU5_MD_BC	BC-MD1	BC-MD1_20080509	Beaver Creek	05/09/08
OU5_MD_BC	BC-MD1	BC-MD1_20080606	Beaver Creek	06/06/08
OU5_MD_BC	BC-MD1	BC-MD1_20080710	Beaver Creek	07/10/08
OU5_MD_BC	BC-MD1	BC-MD1_20080808	Beaver Creek	08/08/08
OU5_MD_BC	BC-MD1	BC-MD1_20080905	Beaver Creek	09/05/08
OU5_MD_BC	BC MD 01	BC-SW-MD-01	Beaver Creek	07/11/17
OU5_MD_BC	BC MD 01	BC-SW-MD-02	Beaver Creek	10/26/17

Notes:

[a] EPCs were estimated separately for each watershed.

EPC = exposure point concentration

HHRA = human health risk assessment

OU5 = Operable Unit 5

OU5_MD_BC = Beaver Creek mine discharge samples

OU5_MD_TC = Tar Creek mine discharge samples

Appendix F3, Table 2. Mine Discharge Exposure Point Concentration Summary

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Exposure Point	Chemicals Detected in Mine Discharge	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic [a]	Rationale
Mine Discharge Tar Creek Watershed	Aluminum	µg/L	1.1E+02	NA	2.2E+02	2.2E+02	µg/L	Maximum	3
	Arsenic	µg/L	2.2E+01	NA	2.5E+01	2.5E+01	µg/L	Maximum	3
	Barium	µg/L	5.7E+00	NA	6.6E+00	6.6E+00	µg/L	Maximum	3
	Beryllium	µg/L	2.0E-01	NA	2.0E-01 J	2.0E-01	µg/L	Maximum	3
	Cadmium	µg/L	5.5E+00	NA	1.0E+01	1.0E+01	µg/L	Maximum	3
	Cobalt	µg/L	1.8E+01	NA	1.8E+01	1.8E+01	µg/L	Maximum	3
	Copper	µg/L	1.1E+00	NA	1.2E+00 J	1.2E+00	µg/L	Maximum	3
	Iron	µg/L	NA	NA	3.2E+04	3.2E+04	µg/L	Maximum	3
	Lead	µg/L	5.1E+00	NA	1.7E+01	5.1E+00	µg/L	Arithmetic Mean [b]	4
	Manganese	µg/L	9.4E+02	NA	1.0E+03	1.0E+03	µg/L	Maximum	3
	Molybdenum	µg/L	5.2E+00	NA	6.1E+00	6.1E+00	µg/L	Maximum	3
	Nickel	µg/L	1.4E+02	NA	1.7E+02	1.7E+02	µg/L	Maximum	3
	Selenium	µg/L	7.8E-01	NA	9.0E-01 J	9.0E-01	µg/L	Maximum	3
	Thallium	µg/L	2.5E-01	NA	3.0E-01 J	3.0E-01	µg/L	Maximum	3
	Vanadium	µg/L	3.0E-01	NA	3.0E-01 J	3.0E-01	µg/L	Maximum	3
	Zinc	µg/L	5.1E+03	NA	5.7E+03	5.7E+03	µg/L	Maximum	3
Mine Discharge Beaver Creek Watershed	Aluminum	µg/L	3.3E+01	4.1E+01 N	8.6E+01	4.1E+01	µg/L	95% KM (t) UCL	1
	Arsenic	µg/L	2.5E+01	NA	5.1E+01	5.1E+01	µg/L	Maximum	3
	Barium	µg/L	1.6E+01	NA	1.7E+01	1.7E+01	µg/L	Maximum	3
	Cadmium	µg/L	2.2E+00	2.8E+00 G	6.6E+00	2.8E+00	µg/L	95% KM Adjusted Gamma UCL	2
	Chromium	µg/L	NA	NA	3.4E+00	3.4E+00	µg/L	Maximum	3
	Cobalt	µg/L	2.5E+00	3.0E+00 N	5.0E+00	3.0E+00	µg/L	95% KM (t) UCL	1
	Copper	µg/L	2.8E+00	3.7E+00 G	7.9E+00	3.7E+00	µg/L	95% KM Adjusted Gamma UCL	2
	Iron	µg/L	7.2E+03	8.1E+03 G	1.4E+04	8.1E+03	µg/L	95% Adjusted Gamma UCL	2
	Lead	µg/L	1.6E+01	NA	5.6E+01	1.6E+01	µg/L	Arithmetic Mean [b]	4
	Manganese	µg/L	2.0E+02	2.0E+02 N	2.3E+02	2.0E+02	µg/L	95% Student's-t UCL	1
	Molybdenum	µg/L	NA	NA	5.5E+00	5.5E+00	µg/L	Maximum	3
	Nickel	µg/L	2.8E+01	3.0E+01 N	3.7E+01	3.0E+01	µg/L	95% Student's-t UCL	1
	Zinc	µg/L	2.2E+03	2.3E+03 N	2.9E+03	2.3E+03	µg/L	95% Student's-t UCL	1

Appendix F3, Table 2. Mine Discharge Exposure Point Concentration Summary

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Notes:

[a] ProUCL Version 5.1.002 (EPA, 2016) and user guide (EPA, 2015) were used to calculate the EPCs.
[b] The arithmetic mean values, calculated using 1/2 the detection limit for non-detected values, were used as the lead EPCs.

Statistics: Maximum - Maximum detected value
Adjusted Gamma - UCL adjusted for level significance assuming gamma distribution
KM (t) - UCL based upon Kaplan-Meier estimates using the Student's t-distribution critical value
KM Adjusted Gamma - UCL based upon Kaplan-Meier estimates, adjusted for level significance assuming gamma distribution
Student's-t - UCL based on Student's t statistic assuming normal distribution

(1) Shapiro-Wilk W/Lilliefors Test indicates data are normally distributed.
(2) Anderson-Darling and/or Kolmogorov-Smirnov Tests indicate data are gamma distributed.
(3) The maximum detected concentration was used as the EPC because there were less than 8 samples or 4 detected concentrations.
(4) The arithmetic mean concentration was used as the EPC for lead.

µg/L = micrograms per liter
EPC = exposure point concentration
J = result is estimated
NA = not available
UCL = upper confidence limit

EPA. 2015. ProUCL Version 5.1 User Guide. Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations. EPA/600/R-07/041. October.
EPA. 2016. ProUCL, Version 5.1.02. Prepared by Lockheed Martin Environmental Services. June.

Appendix F3, Table 3. Comparison of Non-carcinogenic Hazard Estimates between Surface Water and Mine Discharge Data (Tribal Lifeway)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Chemicals Detected in Mine Discharge	Target Organ		Hazard Quotient															
				Surface Water [a]								Mine Discharge [b]							
		Ingestion/Dermal	Inhalation	EPC	SW (Rivers & Creeks)		SW (Potable Use)		SW (Sweat Lodge)			EPC	MD (Rivers & Creeks)		MD (Potable Use)		MD (Sweat Lodge)		
				(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Inhalation	(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Inhalation
Tar Creek	Aluminum	Nervous	Nervous	4.7E-01	1.4E-02	7.7E-04	2.4E-02	1.1E-04	3.1E-02	2.0E-04	6.5E-01	2.2E-01	6.8E-03	3.6E-04	1.2E-02	5.1E-05	1.5E-02	9.4E-05	3.1E-01
	Arsenic	Cardiovascular, Dermal	Reproductive, Developmental, Cardiovascular, Nervous, Respiratory, Dermal	3.4E-02	3.5E+00	1.8E-01	5.9E+00	2.6E-02	7.5E+00	4.8E-02	1.6E+01	2.5E-02	2.6E+00	1.4E-01	4.4E+00	1.9E-02	5.6E+00	3.6E-02	1.2E+01
	Barium	Urinary	Developmental	5.0E-02	7.7E-03	5.8E-03	1.3E-02	8.2E-04	1.7E-02	1.5E-03	6.9E-01	6.6E-03	1.0E-03	7.7E-04	1.7E-03	1.1E-04	2.2E-03	2.0E-04	9.1E-02
	Beryllium	Gastrointestinal	Immune, Respiratory	2.8E-04	4.3E-03	3.3E-02	7.3E-03	4.6E-03	9.3E-03	8.5E-03	9.7E-02	2.0E-04	3.1E-03	2.3E-02	5.2E-03	3.3E-03	6.7E-03	6.1E-03	6.9E-02
	Cadmium	Urinary	Urinary	1.6E-02	1.0E+00	1.1E+00	1.7E+00	1.5E-01	2.2E+00	2.8E-01	1.1E+01	1.0E-02	6.3E-01	6.7E-01	1.1E+00	9.4E-02	1.4E+00	1.7E-01	7.1E+00
	Cobalt	Endocrine	Respiratory	3.2E-02	3.2E+00	6.9E-02	5.5E+00	9.7E-03	7.0E+00	1.8E-02	3.6E+01	1.8E-02	1.9E+00	4.0E-02	3.2E+00	5.6E-03	4.1E+00	1.0E-02	2.1E+01
	Copper	Gastrointestinal	NA	6.1E-03	4.7E-03	2.5E-04	8.0E-03	3.5E-05	1.0E-02	6.5E-05	NA	1.2E-03	9.2E-04	4.9E-05	1.6E-03	6.9E-06	2.0E-03	1.3E-05	NA
	Iron	Gastrointestinal	NA	5.1E+01	2.3E+00	1.2E-01	3.8E+00	1.7E-02	4.9E+00	3.1E-02	NA	3.2E+01	1.4E+00	7.5E-02	2.4E+00	1.1E-02	3.1E+00	1.9E-02	NA
	Manganese	Nervous	Nervous	1.6E+00	2.1E+00	2.8E+00	3.5E+00	3.9E-01	4.5E+00	7.2E-01	2.2E+02	1.0E+00	1.3E+00	1.7E+00	2.2E+00	2.4E-01	2.8E+00	4.4E-01	1.4E+02
	Molybdenum	Urinary	NA	1.0E-02	6.2E-02	3.3E-03	1.0E-01	4.6E-04	1.3E-01	8.5E-04	NA	6.1E-03	3.8E-02	2.0E-03	6.3E-02	2.8E-04	8.1E-02	5.2E-04	NA
	Nickel	Whole Body	Respiratory	3.3E-01	5.1E-01	1.4E-01	8.7E-01	1.9E-02	1.1E+00	3.5E-02	2.6E+01	1.7E-01	2.5E-01	6.7E-02	4.3E-01	9.5E-03	5.5E-01	1.8E-02	1.3E+01
	Selenium	Nervous, Hematologic, Dermal	Hepatic, Cardiovascular, Nervous	8.1E-04	5.0E-03	2.6E-04	8.4E-03	3.7E-05	1.1E-02	6.9E-05	2.8E-04	9.0E-04	5.5E-03	2.9E-04	9.4E-03	4.1E-05	1.2E-02	7.6E-05	3.1E-04
	Thallium	NA	NA	2.3E-04	NA	NA	NA	NA	NA	NA	NA	3.0E-04	NA	NA	NA	NA	NA	NA	NA
	Vanadium	Dermal	Respiratory	8.2E-03	5.1E-02	1.0E-01	8.6E-02	1.5E-02	1.1E-01	2.7E-02	5.7E-01	3.0E-04	1.8E-03	3.8E-03	3.1E-03	5.3E-04	4.0E-03	9.8E-04	2.1E-02
	Zinc	Immune, Hematologic	NA	6.3E+00	6.5E-01	2.1E-02	1.1E+00	2.9E-03	1.4E+00	5.3E-03	NA	5.7E+00	5.9E-01	1.9E-02	9.9E-01	2.6E-03	1.3E+00	4.9E-03	NA
	Exposure Route Total				13	4	23	0.6	29	1	315		9	3	15	0.4	19	0.7	191
	Exposure Scenario Total					18		23			345			11		15			210
	Total										368								226
	Target Organ-Specific HI										Total Cardiovascular HI =	33						Total Cardiovascular HI =	24
											Total Dermal HI =	33						Total Dermal HI =	24
											Total Endocrine HI =	16						Total Endocrine HI =	9
											Total Gastrointestinal HI =	11						Total Gastrointestinal HI =	7
											Total Hematologic HI =	3						Total Hematologic HI =	3
											Total Hepatic HI =	0.0003						Total Hepatic HI =	0.0003
											Total Immune HI =	3						Total Immune HI =	3
											Total Nervous HI =	254						Total Nervous HI =	159
											Total Reproductive, Developmental HI =	16						Total Reproductive, Developmental HI =	12
											Total Respiratory HI =	78						Total Respiratory HI =	45
											Total Urinary HI =	18						Total Urinary HI =	11

Appendix F3, Table 3. Comparison of Non-carcinogenic Hazard Estimates between Surface Water and Mine Discharge Data (Tribal Lifeway)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Chemicals Detected in Mine Discharge	Target Organ		Hazard Quotient														
				Surface Water [a]								Mine Discharge [b]						
		Ingestion/Dermal	Inhalation	EPC	SW (Rivers & Creeks)		SW (Potable Use)		SW (Sweat Lodge)			EPC	MD (Rivers & Creeks)		MD (Potable Use)		MD (Sweat Lodge)		
				(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Inhalation	(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Inhalation
Beaver Creek	Aluminum	Nervous	Nervous	1.4E+00	4.3E-02	2.3E-03	7.3E-02	3.2E-04	9.4E-02	6.0E-04	1.9E+00	4.1E-02	1.2E-03	6.6E-05	2.1E-03	9.3E-06	2.7E-03	1.7E-05	5.6E-02
	Arsenic	Cardiovascular, Dermal	Reproductive, Developmental	8.4E-03	8.6E-01	4.6E-02	1.5E+00	6.4E-03	1.9E+00	1.2E-02	3.9E+00	5.1E-02	5.2E+00	2.8E-01	8.8E+00	3.9E-02	1.1E+01	7.2E-02	2.3E+01
	Barium	Urinary	Developmental	7.5E-02	1.1E-02	8.7E-03	1.9E-02	1.2E-03	2.5E-02	2.3E-03	1.0E+00	1.7E-02	2.6E-03	2.0E-03	4.4E-03	2.8E-04	5.6E-03	5.1E-04	2.3E-01
	Cadmium	Urinary	Urinary	1.8E-03	1.1E-01	1.2E-01	1.9E-01	1.6E-02	2.4E-01	3.0E-02	1.2E+00	2.8E-03	1.7E-01	1.9E-01	3.0E-01	2.6E-02	3.8E-01	4.8E-02	2.0E+00
	Chromium	Not specified	Respiratory	3.3E-03	3.4E-02	1.4E-01	5.7E-02	2.0E-02	7.3E-02	3.7E-02	2.8E+00	3.4E-03	3.5E-02	1.5E-01	5.9E-02	2.1E-02	7.6E-02	3.9E-02	3.0E+00
	Cobalt	Endocrine	Respiratory	7.9E-03	8.1E-01	1.7E-02	1.4E+00	2.4E-03	1.7E+00	4.4E-03	9.0E+00	3.0E-03	3.1E-01	6.5E-03	5.2E-01	9.2E-04	6.7E-01	1.7E-03	3.5E+00
	Copper	Gastrointestinal	NA	6.4E-03	4.9E-03	2.6E-04	8.3E-03	3.6E-05	1.1E-02	6.8E-05	NA	3.7E-03	2.8E-03	1.5E-04	4.8E-03	2.1E-05	6.2E-03	3.9E-05	NA
	Iron	Gastrointestinal	NA	1.8E+00	7.9E-02	4.2E-03	1.3E-01	5.9E-04	1.7E-01	1.1E-03	NA	8.1E+00	3.6E-01	1.9E-02	6.0E-01	2.7E-03	7.7E-01	4.9E-03	NA
	Manganese	Nervous	Nervous	2.3E-01	2.9E-01	3.9E-01	4.9E-01	5.4E-02	6.3E-01	1.0E-01	3.1E+01	2.0E-01	2.6E-01	3.5E-01	4.4E-01	4.9E-02	5.7E-01	9.0E-02	2.8E+01
	Molybdenum	Urinary	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.5E-03	3.4E-02	1.8E-03	5.7E-02	2.5E-04	7.3E-02	4.7E-04	NA
	Nickel	Whole Body	Respiratory	1.5E-02	2.2E-02	5.9E-03	3.8E-02	8.3E-04	4.8E-02	1.5E-03	1.1E+00	3.0E-02	4.5E-02	1.2E-02	7.7E-02	1.7E-03	9.8E-02	3.1E-03	2.3E+00
	Zinc	Immune, Hematologic	NA	5.9E-01	6.0E-02	1.9E-03	1.0E-01	2.7E-04	1.3E-01	5.0E-04	NA	2.3E+00	2.4E-01	7.6E-03	4.0E-01	1.1E-03	5.2E-01	2.0E-03	NA
	Exposure Route Total				2	0.7	4	0.1	5	0.2	52		7	1	11	0.1	14	0.3	63
	Exposure Scenario Total					3		4			58			8		11			77
	Total										62								89
	Target Organ-Specific HI																		
											Total Cardiovascular HI =							Total Cardiovascular HI =	
											8								49
											Total Dermal HI =							Total Dermal HI =	
											8								49
											Total Endocrine HI =							Total Endocrine HI =	
											4								2
											Total Gastrointestinal HI =							Total Gastrointestinal HI =	
											0.4								2
											Total Immune HI =							Total Immune HI =	
											0.3								1
											Total Hematologic HI =							Total Hematologic HI =	
											0.3								1
											Total Nervous HI =							Total Nervous HI =	
											39								53
											Total Reproductive, Developmental HI =							Total Reproductive, Developmental HI =	
											4								23
											Total Respiratory HI =							Total Respiratory HI =	
											17								32
											Total Urinary HI =							Total Urinary HI =	
											2								3
											Total Whole Body HI =							Total Whole Body HI =	
											0.1								0.2

Notes:

[a] Surface water hazard quotients for chemicals detected in mine discharge as presented in Appendix B RAGS Part D Table 9.9 (child TLW receptor at Tar Creek) and 9.23 (child TLW receptor at Beaver Creek).

[b] Mine discharge hazard quotients calculated based on the same exposure factors as surface water.

EPC = exposure point concentration

HI = hazard index

MD = mine discharge

mg/L = milligrams per liter

NA = not applicable

SW = surface water

TLW = tribal lifeway

Appendix F3, Table 4. Comparison of ELCR Estimates between Surface Water and Mine Discharge Data (Tribal Lifeway)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Chemicals Detected in Mine Discharge	ELCR															
		Surface Water [a]								Mine Discharge [b]							
		EPC	SW (Rivers & Creeks)		SW (Potable Use)		SW (Sweat Lodge)			EPC	MD (Rivers & Creeks)		MD (Potable Use)		MD (Sweat Lodge)		
		(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Inhalation	(mg/L)	Ingestion	Dermal	Ingestion	Dermal	Ingestion	Dermal	Inhalation
Tar Creek	Aluminum	4.7E-01	NA	NA	NA	NA	NA	NA	NA	2.2E-01	NA	NA	NA	NA	NA	NA	NA
	Arsenic	3.4E-02	4E-04	7E-05	2E-03	1E-05	9E-04	1E-05	1E-03	2.5E-02	3E-04	6E-05	1E-03	8E-06	6E-04	1E-05	7E-04
	Barium	5.0E-02	NA	NA	NA	NA	NA	NA	NA	6.6E-03	NA	NA	NA	NA	NA	NA	NA
	Beryllium	2.8E-04	NA	NA	NA	NA	NA	NA	5E-06	2.0E-04	NA	NA	NA	NA	NA	NA	3E-06
	Cadmium	1.6E-02	NA	NA	NA	NA	NA	NA	2E-04	1.0E-02	NA	NA	NA	NA	NA	NA	1E-04
	Cobalt	3.2E-02	NA	NA	NA	NA	NA	NA	2E-03	1.8E-02	NA	NA	NA	NA	NA	NA	1E-03
	Copper	6.1E-03	NA	NA	NA	NA	NA	NA	NA	1.2E-03	NA	NA	NA	NA	NA	NA	NA
	Iron	5.1E+01	NA	NA	NA	NA	NA	NA	NA	3.2E+01	NA	NA	NA	NA	NA	NA	NA
	Manganese	1.6E+00	NA	NA	NA	NA	NA	NA	NA	1.0E+00	NA	NA	NA	NA	NA	NA	NA
	Molybdenum	1.0E-02	NA	NA	NA	NA	NA	NA	NA	6.1E-03	NA	NA	NA	NA	NA	NA	NA
	Nickel	3.3E-01	NA	NA	NA	NA	NA	NA	6E-04	1.7E-01	NA	NA	NA	NA	NA	NA	3E-04
	Selenium	8.1E-04	NA	NA	NA	NA	NA	NA	NA	9.0E-04	NA	NA	NA	NA	NA	NA	NA
	Thallium	2.3E-04	NA	NA	NA	NA	NA	NA	NA	3.0E-04	NA	NA	NA	NA	NA	NA	NA
	Vanadium	8.2E-03	NA	NA	NA	NA	NA	NA	NA	3.0E-04	NA	NA	NA	NA	NA	NA	NA
	Zinc	6.3E+00	NA	NA	NA	NA	NA	NA	NA	5.7E+00	NA	NA	NA	NA	NA	NA	NA
	Exposure Route Total		4.E-04	7.E-05	2.E-03	1.E-05	9.E-04	1.E-05	4.E-03		3.E-04	6.E-05	1.E-03	8.E-06	6.E-04	1.E-05	2.E-03
	Exposure Scenario Total			5.E-04		2.E-03			5.E-03			4.E-04		1.E-03			3.E-03
	Total								6.E-03								4.E-03
Beaver Creek	Aluminum	1.4E+00	NA	NA	NA	NA	NA	NA	NA	4.1E-02	NA	NA	NA	NA	NA	NA	NA
	Arsenic	8.4E-03	1E-04	2E-05	5E-04	3E-06	2E-04	4E-06	2E-04	5.1E-02	7E-04	1E-04	3E-03	2E-05	1E-03	2E-05	1E-03
	Barium	7.5E-02	NA	NA	NA	NA	NA	NA	NA	1.7E-02	NA	NA	NA	NA	NA	NA	NA
	Cadmium	1.8E-03	NA	NA	NA	NA	NA	NA	2E-05	2.8E-03	NA	NA	NA	NA	NA	NA	3E-05
	Chromium	3.3E-03	3E-05	2E-04	7E-05	3E-05	3E-05	3E-05	1E-03	3.4E-03	3E-05	2E-04	8E-05	3E-05	3E-05	3E-05	1E-03
	Cobalt	7.9E-03	NA	NA	NA	NA	NA	NA	5E-04	3.0E-03	NA	NA	NA	NA	NA	NA	2E-04
	Copper	6.4E-03	NA	NA	NA	NA	NA	NA	NA	3.7E-03	NA	NA	NA	NA	NA	NA	NA
	Iron	1.8E+00	NA	NA	NA	NA	NA	NA	NA	8.1E+00	NA	NA	NA	NA	NA	NA	NA
	Lead	1.1E-02	NA	NA	NA	NA	NA	NA	NA	1.6E-02	NA	NA	NA	NA	NA	NA	NA
	Manganese	2.3E-01	NA	NA	NA	NA	NA	NA	NA	2.0E-01	NA	NA	NA	NA	NA	NA	NA
	Molybdenum	NA	NA	NA	NA	NA	NA	NA	NA	5.5E-03	NA	NA	NA	NA	NA	NA	NA
	Nickel	1.5E-02	NA	NA	NA	NA	NA	NA	3E-05	3.0E-02	NA	NA	NA	NA	NA	NA	5E-05
	Zinc	5.9E-01	NA	NA	NA	NA	NA	NA	NA	2.3E+00	NA	NA	NA	NA	NA	NA	NA
	Exposure Route Total		1.E-04	2.E-04	5.E-04	3.E-05	2.E-04	3.E-05	2.E-03		7.E-04	3.E-04	3.E-03	5.E-05	1.E-03	5.E-05	3.E-03
	Exposure Scenario Total			4.E-04		6.E-04			2.E-03			1.E-03		3.E-03			5.E-03
	Total								3.E-03								8.E-03

Notes:

[a] Surface water ELCR for chemicals detected in mine discharge as presented in Appendix B RAGS Part D Table 9.10 (adult/child aggregate TLW receptor at Tar Creek) and 9.24 (adult/child aggregate TLW receptor at Beaver Creek).

[b] Mine discharge ELCR calculated based on the same exposure factors as surface water.

ELCR = excess lifetime cancer risk
EPC = exposure point concentration
MD = mine discharge
mg/L = milligrams per liter
NA = not applicable
SW = surface water
TLW = tribal lifeway

Appendix F3, Table 5. Comparison of Non-carcinogenic Hazard Estimates between Surface Water and Mine Discharge Data (General Public - Wading)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Chemicals Detected in Mine Discharge	Target Organ Ingestion/Dermal	Hazard Quotient			
			Surface Water		Mine Discharge	
			EPC (mg/L)	SW (Rivers & Creeks) Dermal	EPC (mg/L)	MD (Rivers & Creeks) Dermal
Tar Creek	Aluminum	Nervous	4.7E-01	1.1E-05	2.2E-01	5.4E-06
	Arsenic	Cardiovascular, Dermal	3.4E-02	2.7E-03	2.5E-02	2.0E-03
	Barium	Urinary	5.0E-02	8.7E-05	6.6E-03	1.1E-05
	Beryllium	Gastrointestinal	2.8E-04	4.9E-04	2.0E-04	3.5E-04
	Cadmium	Urinary	1.6E-02	1.6E-02	1.0E-02	1.0E-02
	Cobalt	Endocrine	3.2E-02	1.0E-03	1.8E-02	5.9E-04
	Copper	Gastrointestinal	6.1E-03	3.7E-06	1.2E-03	7.3E-07
	Iron	Gastrointestinal	5.1E+01	1.8E-03	3.2E+01	1.1E-03
	Manganese	Nervous	1.6E+00	4.1E-02	1.0E+00	2.5E-02
	Molybdenum	Urinary	1.0E-02	4.9E-05	6.1E-03	3.0E-05
	Nickel	Whole Body	3.3E-01	2.0E-03	1.7E-01	1.0E-03
	Selenium	Nervous, Hematologic, Dermal	8.1E-04	3.9E-06	9.0E-04	4.4E-06
	Thallium	NA	2.3E-04	NA	3.0E-04	NA
	Vanadium	Dermal	8.2E-03	1.5E-03	3.0E-04	5.6E-05
	Zinc	Immune, Hematologic	6.3E+00	3.1E-04	5.7E+00	2.8E-04
	Exposure Route Total			0.07		0.04
	Exposure Scenario Total			0.07		0.04
	Total			0.07		0.04
	Target Organ-Specific HI		Total Cardiovascular HI =	0.003	Total Cardiovascular HI =	0.002
			Total Dermal HI =	0.004	Total Dermal HI =	0.002
			Total Endocrine HI =	0.001	Total Endocrine HI =	0.0006
			Total Gastrointestinal HI =	0.002	Total Gastrointestinal HI =	0.001
			Total Hematologic HI =	0.0003	Total Hematologic HI =	0.0003
			Total Immune HI =	0.0003	Total Immune HI =	0.0003
			Total Nervous HI =	0.04	Total Nervous HI =	0.03
			Total Urinary HI =	0.02	Total Urinary HI =	0.01

Appendix F3, Table 5. Comparison of Non-carcinogenic Hazard Estimates between Surface Water and Mine Discharge Data (General Public - Wading)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Chemicals Detected in Mine Discharge	Target Organ Ingestion/Dermal	Hazard Quotient			
			Surface Water		Mine Discharge	
			EPC (mg/L)	SW (Rivers & Creeks) Dermal	EPC (mg/L)	MD (Rivers & Creeks) Dermal
Beaver Creek	Aluminum	Nervous	1.4E+00	3.4E-05	4.1E-02	9.8E-07
	Arsenic	Cardiovascular, Dermal	8.4E-03	6.8E-04	5.1E-02	4.1E-03
	Barium	Urinary	7.5E-02	1.3E-04	1.7E-02	2.9E-05
	Cadmium	Urinary	1.8E-03	1.7E-03	2.8E-03	2.8E-03
	Chromium	Not specified	3.3E-03	2.1E-03	3.4E-03	2.2E-03
	Cobalt	Endocrine	7.9E-03	2.5E-04	3.0E-03	9.7E-05
	Copper	Gastrointestinal	6.4E-03	3.9E-06	3.7E-03	2.2E-06
	Iron	Gastrointestinal	1.8E+00	6.2E-05	8.1E+00	2.8E-04
	Manganese	Nervous	2.3E-01	5.7E-03	2.0E-01	5.2E-03
	Molybdenum	Urinary	NA	NA	5.5E-03	2.7E-05
	Nickel	Whole Body	1.5E-02	8.8E-05	3.0E-02	1.8E-04
	Zinc	Immune, Hematologic	5.9E-01	2.8E-05	2.3E+00	1.1E-04
	Exposure Route Total			0.01		0.01
	Exposure Scenario Total			0.01		0.01
	Total			0.01		0.01
	Target Organ-Specific HI	Total Cardiovascular HI =		0.0007	Total Cardiovascular HI =	0.004
		Total Dermal HI =		0.0007	Total Dermal HI =	0.004
		Total Endocrine HI =		0.0003	Total Endocrine HI =	0.0001
		Total Gastrointestinal HI =		0.00007	Total Gastrointestinal HI =	0.0003
		Total Hematologic HI =		0.00003	Total Hematologic HI =	0.0001
		Total Immune HI =		0.00003	Total Immune HI =	0.0001
		Total Nervous HI =		0.006	Total Nervous HI =	0.005
		Total Urinary HI =		0.002	Total Urinary HI =	0.003
		Total Whole Body HI =		0.00009	Total Whole Body HI =	0.0002

Notes:

[a] Surface water hazard quotients for wading scenario (dermal only) for chemicals detected in mine discharge as presented in Appendix B RAGS Part D Table 9.13 (child general public receptor at Tar Creek) and 9.27 (child general public receptor at Beaver Creek).

[b] Mine discharge hazard quotients calculated based on the same exposure factors as the general public surface water wading (dermal only) scenario.

EPC = exposure point concentration
HI = hazard index
MD = mine discharge
mg/L = milligrams per liter
NA = not applicable
SW = surface water

Appendix F3, Table 6. Comparison of ELCR Estimates between Surface Water and Mine Discharge Data (General Public - Wading)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Chemicals Detected in Mine Discharge	ELCR			
		Surface Water		Mine Discharge	
		EPC (mg/L)	SW (Rivers & Creeks) Dermal	EPC (mg/L)	MD (Rivers & Creeks) Dermal
Tar Creek	Aluminum	4.7E-01	NA	2.2E-01	NA
	Arsenic	3.4E-02	3E-07	2.5E-02	2E-07
	Barium	5.0E-02	NA	6.6E-03	NA
	Beryllium	2.8E-04	NA	2.0E-04	NA
	Cadmium	1.6E-02	NA	1.0E-02	NA
	Cobalt	3.2E-02	NA	1.8E-02	NA
	Copper	6.1E-03	NA	1.2E-03	NA
	Iron	5.1E+01	NA	3.2E+01	NA
	Manganese	1.6E+00	NA	1.0E+00	NA
	Molybdenum	1.0E-02	NA	6.1E-03	NA
	Nickel	3.3E-01	NA	1.7E-01	NA
	Selenium	8.1E-04	NA	9.0E-04	NA
	Thallium	2.3E-04	NA	3.0E-04	NA
	Vanadium	8.2E-03	NA	3.0E-04	NA
	Zinc	6.3E+00	NA	5.7E+00	NA
	Exposure Route Total		3.E-07		2.E-07
	Exposure Scenario Total		3.E-07		2.E-07
	Total		3.E-07		2.E-07

Appendix F3, Table 6. Comparison of ELCR Estimates between Surface Water and Mine Discharge Data (General Public - Wading)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Watershed	Chemicals Detected in Mine Discharge	ELCR			
		Surface Water		Mine Discharge	
		EPC (mg/L)	SW (Rivers & Creeks) Dermal	EPC (mg/L)	MD (Rivers & Creeks) Dermal
Beaver Creek	Aluminum	1.4E+00	NA	4.1E-02	NA
	Arsenic	8.4E-03	7E-08	5.1E-02	4E-07
	Barium	7.5E-02	NA	1.7E-02	NA
	Cadmium	1.8E-03	NA	2.8E-03	NA
	Chromium	3.3E-03	2E-06	3.4E-03	2E-06
	Cobalt	7.9E-03	NA	3.0E-03	NA
	Copper	6.4E-03	NA	3.7E-03	NA
	Iron	1.8E+00	NA	8.1E+00	NA
	Lead	1.1E-02	NA	1.6E-02	NA
	Manganese	2.3E-01	NA	2.0E-01	NA
	Molybdenum	NA	NA	5.5E-03	NA
	Nickel	1.5E-02	NA	3.0E-02	NA
	Zinc	5.9E-01	NA	2.3E+00	NA
	Exposure Route Total		2.E-06		3.E-06
	Exposure Scenario Total		2.E-06		3.E-06
	Total		2.E-06		3.E-06

Notes:

[a] Surface water ELCR for wading scenario (dermal only) for chemicals detected in mine discharge as presented in Appendix B RAGS Part D Table 9.14 (adult/child aggregate general public receptor at Tar Creek) and 9.28 (adult/child aggregate general public receptor at Beaver Creek).

[b] Mine discharge ELCR calculated based on the same exposure factors as the general public surface water wading (dermal only) scenario.

ELCR = excess lifetime cancer risk
EPC = exposure point concentration
MD = mine discharge
mg/L = milligrams per liter
NA = not applicable
SW = surface water

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 3:43:05 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Aluminum (µg/L)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	19
Number of Detects	17	Number of Non-Detects	2
Number of Distinct Detects	17	Number of Distinct Non-Detects	2
Minimum Detect	6.642	Minimum Non-Detect	1.7
Maximum Detect	85.81	Maximum Non-Detect	100
Variance Detects	457.2	Percent Non-Detects	10.53%
Mean Detects	33.24	SD Detects	21.38
Median Detects	28.23	CV Detects	0.643
Skewness Detects	1.342	Kurtosis Detects	1.488
Mean of Logged Detects	3.319	SD of Logged Detects	0.64

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.876	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.192	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	31.49	KM Standard Error of Mean	5.203
KM SD	21.41	95% KM (BCA) UCL	41.07
95% KM (t) UCL	40.51	95% KM (Percentile Bootstrap) UCL	40.03
95% KM (z) UCL	40.05	95% KM Bootstrap t UCL	43.58
90% KM Chebyshev UCL	47.1	95% KM Chebyshev UCL	54.17
97.5% KM Chebyshev UCL	63.98	99% KM Chebyshev UCL	83.25

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.22	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.113	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.211	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.863	k star (bias corrected MLE)	2.397
Theta hat (MLE)	11.61	Theta star (bias corrected MLE)	13.87
nu hat (MLE)	97.33	nu star (bias corrected)	81.49
Mean (detects)	33.24		

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	31.2
Maximum	85.81	Median	27.74
SD	21.56	CV	0.691
k hat (MLE)	1.065	k star (bias corrected MLE)	0.932
Theta hat (MLE)	29.31	Theta star (bias corrected MLE)	33.49
nu hat (MLE)	40.45	nu star (bias corrected)	35.4
Adjusted Level of Significance (β)	0.0369		
Approximate Chi Square Value (35.40, α)	22.79	Adjusted Chi Square Value (35.40, β)	21.9
95% Gamma Approximate UCL (use when n>=50)	48.47	95% Gamma Adjusted UCL (use when n<50)	50.43

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	31.49	SD (KM)	21.41
Variance (KM)	458.6	SE of Mean (KM)	5.203
k hat (KM)	2.162	k star (KM)	1.856
nu hat (KM)	82.16	nu star (KM)	70.52
theta hat (KM)	14.56	theta star (KM)	16.97
80% gamma percentile (KM)	47.56	90% gamma percentile (KM)	62.33
95% gamma percentile (KM)	76.49	99% gamma percentile (KM)	108

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (70.52, α)	52.19	Adjusted Chi Square Value (70.52, β)	50.81
95% Gamma Approximate KM-UCL (use when n>=50)	42.55	95% Gamma Adjusted KM-UCL (use when n<50)	43.7

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.983	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0878	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	31.39	Mean in Log Scale	3.232
SD in Original Scale	21.17	SD in Log Scale	0.702
95% t UCL (assumes normality of ROS data)	39.81	95% Percentile Bootstrap UCL	39.93
95% BCA Bootstrap UCL	41.14	95% Bootstrap t UCL	42.37
95% H-UCL (Log ROS)	46.85		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.164	KM Geo Mean	23.67
KM SD (logged)	0.879	95% Critical H Value (KM-Log)	2.443
KM Standard Error of Mean (logged)	0.213	95% H-UCL (KM -Log)	57.75
KM SD (logged)	0.879	95% Critical H Value (KM-Log)	2.443
KM Standard Error of Mean (logged)	0.213		

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	32.42	Mean in Log Scale	3.167
SD in Original Scale	21.9	SD in Log Scale	1.016
95% t UCL (Assumes normality)	41.13	95% H-Stat UCL	74.75

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 40.51

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic (µg/L)

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	8.8	Mean	24.82
Maximum	50.86	Median	19.81
SD	19.29	Std. Error of Mean	9.645
Coefficient of Variation	0.777	Skewness	1.052

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.896	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.252	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	47.52	95% Adjusted-CLT UCL (Chen-1995)	46.1
		95% Modified-t UCL (Johnson-1978)	48.36

Gamma GOF Test

A-D Test Statistic	0.308	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.66	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.279	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.398	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics

k hat (MLE)	2.249	k star (bias corrected MLE)	0.729
Theta hat (MLE)	11.03	Theta star (bias corrected MLE)	34.04
nu hat (MLE)	18	nu star (bias corrected)	5.832
MLE Mean (bias corrected)	24.82	MLE Sd (bias corrected)	29.07
		Approximate Chi Square Value (0.05)	1.555
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	93.1	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.238	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.375	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.175	Mean of logged Data	2.973
Maximum of Logged Data	3.929	SD of logged Data	0.804

Assuming Lognormal Distribution

95% H-UCL	338.4	90% Chebyshev (MVUE) UCL	53.01
95% Chebyshev (MVUE) UCL	65.85	97.5% Chebyshev (MVUE) UCL	83.67
99% Chebyshev (MVUE) UCL	118.7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	40.68	95% Jackknife UCL	47.52
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	53.75	95% Chebyshev(Mean, Sd) UCL	66.86
97.5% Chebyshev(Mean, Sd) UCL	85.05	99% Chebyshev(Mean, Sd) UCL	120.8

Suggested UCL to Use

95% Student's-t UCL 47.52

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Barium (µg/L)

General Statistics

Total Number of Observations	2	Number of Distinct Observations	2
		Number of Missing Observations	0
Minimum	15.3	Mean	16.1
Maximum	16.9	Median	16.1

Warning: This data set only has 2 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Barium (µg/L) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Cadmium (µg/L)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
Number of Detects	19	Number of Non-Detects	1
Number of Distinct Detects	19	Number of Distinct Non-Detects	1
Minimum Detect	0.7	Minimum Non-Detect	5
Maximum Detect	6.575	Maximum Non-Detect	5
Variance Detects	1.761	Percent Non-Detects	5%
Mean Detects	2.185	SD Detects	1.327
Median Detects	1.954	CV Detects	0.607
Skewness Detects	2.219	Kurtosis Detects	6.241
Mean of Logged Detects	0.648	SD of Logged Detects	0.513

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.784	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.276	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.173	KM Standard Error of Mean	0.295
KM SD	1.273	95% KM (BCA) UCL	2.694
95% KM (t) UCL	2.683	95% KM (Percentile Bootstrap) UCL	2.67
95% KM (z) UCL	2.658	95% KM Bootstrap t UCL	3.004
90% KM Chebyshev UCL	3.059	95% KM Chebyshev UCL	3.46
97.5% KM Chebyshev UCL	4.017	99% KM Chebyshev UCL	5.111

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.502	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.206	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.199	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma Statistics on Detected Data Only

k hat (MLE)	3.907	k star (bias corrected MLE)	3.325
Theta hat (MLE)	0.559	Theta star (bias corrected MLE)	0.657
nu hat (MLE)	148.5	nu star (bias corrected)	126.3
Mean (detects)	2.185		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.7	Mean	2.171
Maximum	6.575	Median	1.941
SD	1.293	CV	0.596
k hat (MLE)	4.091	k star (bias corrected MLE)	3.51
Theta hat (MLE)	0.531	Theta star (bias corrected MLE)	0.618
nu hat (MLE)	163.6	nu star (bias corrected)	140.4
Adjusted Level of Significance (β)	0.038		
Approximate Chi Square Value (140.41, α)	114	Adjusted Chi Square Value (140.41, β)	112.2
95% Gamma Approximate UCL (use when n>=50)	2.673	95% Gamma Adjusted UCL (use when n<50)	2.717

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.173	SD (KM)	1.273
Variance (KM)	1.62	SE of Mean (KM)	0.295
k hat (KM)	2.914	k star (KM)	2.51
nu hat (KM)	116.6	nu star (KM)	100.4
theta hat (KM)	0.746	theta star (KM)	0.865
80% gamma percentile (KM)	3.166	90% gamma percentile (KM)	4.01
95% gamma percentile (KM)	4.804	99% gamma percentile (KM)	6.544

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (100.42, α)	78.3	Adjusted Chi Square Value (100.42, β)	76.75
95% Gamma Approximate KM-UCL (use when n>=50)	2.786	95% Gamma Adjusted KM-UCL (use when n<50)	2.842

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.171	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.167	Mean in Log Scale	0.646
SD in Original Scale	1.294	SD in Log Scale	0.499
95% t UCL (assumes normality of ROS data)	2.667	95% Percentile Bootstrap UCL	2.686
95% BCA Bootstrap UCL	2.85	95% Bootstrap t UCL	2.935
95% H-UCL (Log ROS)	2.722		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.645	KM Geo Mean	1.905
KM SD (logged)	0.495	95% Critical H Value (KM-Log)	2.015
KM Standard Error of Mean (logged)	0.116	95% H-UCL (KM -Log)	2.708
KM SD (logged)	0.495	95% Critical H Value (KM-Log)	2.015
KM Standard Error of Mean (logged)	0.116		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.2	Mean in Log Scale	0.661
SD in Original Scale	1.294	SD in Log Scale	0.503
95% t UCL (Assumes normality)	2.701	95% H-Stat UCL	2.776

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	2.842	95% GROS Adjusted Gamma UCL	2.717

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Chromium (µg/L)

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
Number of Detects	1	Number of Non-Detects	2
Number of Distinct Detects	1	Number of Distinct Non-Detects	2

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BT

The data set for variable Chromium (µg/L) was not processed!

Cobalt (µg/L)

General Statistics

Total Number of Observations	16	Number of Distinct Observations	16
Number of Detects	15	Number of Non-Detects	1
Number of Distinct Detects	15	Number of Distinct Non-Detects	1

Minimum Detect	1.371	Minimum Non-Detect	20
Maximum Detect	4.958	Maximum Non-Detect	20
Variance Detects	1.048	Percent Non-Detects	6.25%
Mean Detects	2.538	SD Detects	1.024
Median Detects	2.465	CV Detects	0.403
Skewness Detects	1.16	Kurtosis Detects	0.788
Mean of Logged Detects	0.864	SD of Logged Detects	0.372

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.879	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.538	KM Standard Error of Mean	0.264
KM SD	0.989	95% KM (BCA) UCL	3.011
95% KM (t) UCL	3.001	95% KM (Percentile Bootstrap) UCL	2.973
95% KM (z) UCL	2.973	95% KM Bootstrap t UCL	3.133
90% KM Chebyshev UCL	3.331	95% KM Chebyshev UCL	3.69
97.5% KM Chebyshev UCL	4.189	99% KM Chebyshev UCL	5.168

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.497	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.738	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.222	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	7.551	k star (bias corrected MLE)	6.085
Theta hat (MLE)	0.336	Theta star (bias corrected MLE)	0.417
nu hat (MLE)	226.5	nu star (bias corrected)	182.6
Mean (detects)	2.538		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.371	Mean	2.532
Maximum	4.958	Median	2.452
SD	0.989	CV	0.391
k hat (MLE)	8.038	k star (bias corrected MLE)	6.573
Theta hat (MLE)	0.315	Theta star (bias corrected MLE)	0.385
nu hat (MLE)	257.2	nu star (bias corrected)	210.3
Adjusted Level of Significance (β)	0.0335		
Approximate Chi Square Value (210.32, α)	177.8	Adjusted Chi Square Value (210.32, β)	174.4
95% Gamma Approximate UCL (use when n>=50)	2.996	95% Gamma Adjusted UCL (use when n<50)	3.054

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.538	SD (KM)	0.989
Variance (KM)	0.978	SE of Mean (KM)	0.264
k hat (KM)	6.587	k star (KM)	5.393
nu hat (KM)	210.8	nu star (KM)	172.6
theta hat (KM)	0.385	theta star (KM)	0.471
80% gamma percentile (KM)	3.383	90% gamma percentile (KM)	4
95% gamma percentile (KM)	4.561	99% gamma percentile (KM)	5.742

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (172.59, α)	143.2	Adjusted Chi Square Value (172.59, β)	140.2
95% Gamma Approximate KM-UCL (use when n>=50)	3.059	95% Gamma Adjusted KM-UCL (use when n<50)	3.125

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.165	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.528	Mean in Log Scale	0.864
SD in Original Scale	0.99	SD in Log Scale	0.359
95% t UCL (assumes normality of ROS data)	2.961	95% Percentile Bootstrap UCL	2.94
95% BCA Bootstrap UCL	3.041	95% Bootstrap t UCL	3.087
95% H-UCL (Log ROS)	3.023		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.864	KM Geo Mean	2.372
KM SD (logged)	0.359	95% Critical H Value (KM-Log)	1.919
KM Standard Error of Mean (logged)	0.096	95% H-UCL (KM -Log)	3.023
KM SD (logged)	0.359	95% Critical H Value (KM-Log)	1.919
KM Standard Error of Mean (logged)	0.096		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.004	Mean in Log Scale	0.954
SD in Original Scale	2.111	SD in Log Scale	0.508
95% t UCL (Assumes normality)	3.93	95% H-Stat UCL	3.87

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 3.001

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (µg/L)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
Number of Detects	19	Number of Non-Detects	1
Number of Distinct Detects	19	Number of Distinct Non-Detects	1
Minimum Detect	1.367	Minimum Non-Detect	20
Maximum Detect	7.94	Maximum Non-Detect	20
Variance Detects	3.047	Percent Non-Detects	5%
Mean Detects	2.804	SD Detects	1.745
Median Detects	2.118	CV Detects	0.623
Skewness Detects	2.03	Kurtosis Detects	4.031
Mean of Logged Detects	0.898	SD of Logged Detects	0.496

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.749	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.234	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.804	KM Standard Error of Mean	0.4
KM SD	1.699	95% KM (BCA) UCL	3.465
95% KM (t) UCL	3.496	95% KM (Percentile Bootstrap) UCL	3.536
95% KM (z) UCL	3.462	95% KM Bootstrap t UCL	4.174
90% KM Chebyshev UCL	4.005	95% KM Chebyshev UCL	4.549
97.5% KM Chebyshev UCL	5.304	99% KM Chebyshev UCL	6.788

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.854	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.745	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.166	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.199	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.91	k star (bias corrected MLE)	3.327
Theta hat (MLE)	0.717	Theta star (bias corrected MLE)	0.843
nu hat (MLE)	148.6	nu star (bias corrected)	126.4
Mean (detects)	2.804		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.367	Mean	2.792
Maximum	7.94	Median	2.254
SD	1.7	CV	0.609
k hat (MLE)	4.102	k star (bias corrected MLE)	3.52
Theta hat (MLE)	0.681	Theta star (bias corrected MLE)	0.793
nu hat (MLE)	164.1	nu star (bias corrected)	140.8
Adjusted Level of Significance (β)	0.038		
Approximate Chi Square Value (140.81, α)	114.4	Adjusted Chi Square Value (140.81, β)	112.5
95% Gamma Approximate UCL (use when n>=50)	3.437	95% Gamma Adjusted UCL (use when n<50)	3.495

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.804	SD (KM)	1.699
Variance (KM)	2.886	SE of Mean (KM)	0.4
k hat (KM)	2.724	k star (KM)	2.349
nu hat (KM)	108.9	nu star (KM)	93.94
theta hat (KM)	1.029	theta star (KM)	1.194
80% gamma percentile (KM)	4.118	90% gamma percentile (KM)	5.253
95% gamma percentile (KM)	6.327	99% gamma percentile (KM)	8.684

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (93.94, α)	72.59	Adjusted Chi Square Value (93.94, β)	71.1
95% Gamma Approximate KM-UCL (use when n>=50)	3.629	95% Gamma Adjusted KM-UCL (use when n<50)	3.704

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.909	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.901	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.143	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.197	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.786	Mean in Log Scale	0.898
SD in Original Scale	1.701	SD in Log Scale	0.483
95% t UCL (assumes normality of ROS data)	3.444	95% Percentile Bootstrap UCL	3.45
95% BCA Bootstrap UCL	3.607	95% Bootstrap t UCL	3.998
95% H-UCL (Log ROS)	3.442		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.898	KM Geo Mean	2.454
KM SD (logged)	0.483	95% Critical H Value (KM-Log)	2.003
KM Standard Error of Mean (logged)	0.114	95% H-UCL (KM -Log)	3.442
KM SD (logged)	0.483	95% Critical H Value (KM-Log)	2.003
KM Standard Error of Mean (logged)	0.114		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	3.164	Mean in Log Scale	0.968
SD in Original Scale	2.34	SD in Log Scale	0.576
95% t UCL (Assumes normality)	4.068	95% H-Stat UCL	4.1

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	3.704	95% GROS Adjusted Gamma UCL	3.495

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron (µg/L)

General Statistics

Total Number of Observations	19	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	4614	Mean	7186
Maximum	13930	Median	6768
SD	2175	Std. Error of Mean	499
Coefficient of Variation	0.303	Skewness	1.921

Normal GOF Test

Shapiro Wilk Test Statistic	0.82	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.207	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	8051	95% Adjusted-CLT UCL (Chen-1995)	8242
		95% Modified-t UCL (Johnson-1978)	8088

Gamma GOF Test

A-D Test Statistic	0.622	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.741	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.162	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.198	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.25	k star (bias corrected MLE)	12.04
Theta hat (MLE)	504.3	Theta star (bias corrected MLE)	597.1
nu hat (MLE)	541.5	nu star (bias corrected)	457.4
MLE Mean (bias corrected)	7186	MLE Sd (bias corrected)	2071
		Approximate Chi Square Value (0.05)	408.8
Adjusted Level of Significance	0.0369	Adjusted Chi Square Value	404.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	8040	95% Adjusted Gamma UCL (use when n<50)	8120

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.148	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.197	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	8.437	Mean of logged Data	8.844
Maximum of Logged Data	9.542	SD of logged Data	0.262

Assuming Lognormal Distribution

95% H-UCL	8033	90% Chebyshev (MVUE) UCL	8472
95% Chebyshev (MVUE) UCL	9064	97.5% Chebyshev (MVUE) UCL	9886
99% Chebyshev (MVUE) UCL	11501		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8007	95% Jackknife UCL	8051
95% Standard Bootstrap UCL	7986	95% Bootstrap-t UCL	8576
95% Hall's Bootstrap UCL	12572	95% Percentile Bootstrap UCL	8027
95% BCA Bootstrap UCL	8212		
90% Chebyshev(Mean, Sd) UCL	8683	95% Chebyshev(Mean, Sd) UCL	9361
97.5% Chebyshev(Mean, Sd) UCL	10303	99% Chebyshev(Mean, Sd) UCL	12152

Suggested UCL to Use

95% Adjusted Gamma UCL 8120

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (µg/L)

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
Number of Detects	3	Number of Non-Detects	2
Number of Distinct Detects	3	Number of Distinct Non-Detects	2
Minimum Detect	9.023	Minimum Non-Detect	0.4
Maximum Detect	55.93	Maximum Non-Detect	5
Variance Detects	656.4	Percent Non-Detects	40%
Mean Detects	26.52	SD Detects	25.62
Median Detects	14.62	CV Detects	0.966
Skewness Detects	1.64	Kurtosis Detects	N/A
Mean of Logged Detects	2.969	SD of Logged Detects	0.945

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Warning: Data set has only 3 Detected Values.
This is not enough to compute meaningful or reliable statistics and estimates.

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.838	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.346	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	16.07	KM Standard Error of Mean	11.31
KM SD	20.65	95% KM (BCA) UCL	N/A
95% KM (t) UCL	40.18	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	34.68	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	50	95% KM Chebyshev UCL	65.37
97.5% KM Chebyshev UCL	86.7	99% KM Chebyshev UCL	128.6

Gamma GOF Tests on Detected Observations Only
Not Enough Data to Perform GOF Test

Gamma Statistics on Detected Data Only

k hat (MLE)	1.765	k star (bias corrected MLE)	N/A
Theta hat (MLE)	15.03	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	10.59	nu star (bias corrected)	N/A
Mean (detects)	26.52		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	15.92
Maximum	55.93	Median	9.023
SD	23.22	CV	1.459
k hat (MLE)	0.251	k star (bias corrected MLE)	0.234
Theta hat (MLE)	63.43	Theta star (bias corrected MLE)	68.11
nu hat (MLE)	2.51	nu star (bias corrected)	2.337
Adjusted Level of Significance (β)	0.0086		
Approximate Chi Square Value (2.34, α)	0.207	Adjusted Chi Square Value (2.34, β)	0.0843
95% Gamma Approximate UCL (use when n>=50)	180.1	95% Gamma Adjusted UCL (use when n<50)	N/A

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	16.07	SD (KM)	20.65
Variance (KM)	426.3	SE of Mean (KM)	11.31
k hat (KM)	0.606	k star (KM)	0.376
nu hat (KM)	6.061	nu star (KM)	3.758
theta hat (KM)	26.52	theta star (KM)	42.78
80% gamma percentile (KM)	25.74	90% gamma percentile (KM)	45.89
95% gamma percentile (KM)	68.24	99% gamma percentile (KM)	124.8

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (3.76, α)	0.628	Adjusted Chi Square Value (3.76, β)	0.251
95% Gamma Approximate KM-UCL (use when n>=50)	96.13	95% Gamma Adjusted KM-UCL (use when n<50)	240.6

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.767	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.286	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.425	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	16.36	Mean in Log Scale	1.828
SD in Original Scale	22.84	SD in Log Scale	1.699
95% t UCL (assumes normality of ROS data)	38.14	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A	95% Bootstrap t UCL	N/A
95% H-UCL (Log ROS)	23962		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.415	KM Geo Mean	4.115
KM SD (logged)	1.995	95% Critical H Value (KM-Log)	9.364
KM Standard Error of Mean (logged)	1.093	95% H-UCL (KM -Log)	342874
KM SD (logged)	1.995	95% Critical H Value (KM-Log)	9.364
KM Standard Error of Mean (logged)	1.093		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	16.45	Mean in Log Scale	1.643
SD in Original Scale	22.78	SD in Log Scale	2.131
95% t UCL (Assumes normality)	38.17	95% H-Stat UCL	2089423

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 40.18

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Manganese (µg/L)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	165.8	Mean	195.6
Maximum	229.9	Median	196.5
SD	21.81	Std. Error of Mean	4.876
Coefficient of Variation	0.111	Skewness	0.0822

Normal GOF Test

Shapiro Wilk Test Statistic	0.924	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.117	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	204	95% Adjusted-CLT UCL (Chen-1995)	203.7
		95% Modified-t UCL (Johnson-1978)	204

Gamma GOF Test

A-D Test Statistic	0.515	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.126	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	84.49	k star (bias corrected MLE)	71.85
Theta hat (MLE)	2.315	Theta star (bias corrected MLE)	2.722
nu hat (MLE)	3380	nu star (bias corrected)	2874
MLE Mean (bias corrected)	195.6	MLE Sd (bias corrected)	23.08
		Approximate Chi Square Value (0.05)	2751
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	2741

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	204.4	95% Adjusted Gamma UCL (use when n<50)	205.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.923	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.121	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.111	Mean of logged Data	5.27
Maximum of Logged Data	5.438	SD of logged Data	0.112

Assuming Lognormal Distribution

95% H-UCL	204.6	90% Chebyshev (MVUE) UCL	210.3
95% Chebyshev (MVUE) UCL	217	97.5% Chebyshev (MVUE) UCL	226.2
99% Chebyshev (MVUE) UCL	244.4		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	203.6	95% Jackknife UCL	204
95% Standard Bootstrap UCL	203.3	95% Bootstrap-t UCL	204.1
95% Hall's Bootstrap UCL	203.5	95% Percentile Bootstrap UCL	203.5
95% BCA Bootstrap UCL	203.2		
90% Chebyshev(Mean, Sd) UCL	210.2	95% Chebyshev(Mean, Sd) UCL	216.9
97.5% Chebyshev(Mean, Sd) UCL	226.1	99% Chebyshev(Mean, Sd) UCL	244.1

Suggested UCL to Use

95% Student's-t UCL 204

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum (µg/L)

General Statistics

Total Number of Observations	1	Number of Distinct Observations	1
		Number of Missing Observations	0
Minimum	5.5	Mean	5.5
Maximum	5.5	Median	5.5

Warning: This data set only has 1 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Molybdenum (µg/L) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Nickel (µg/L)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	20.27	Mean	27.5
Maximum	36.79	Median	27.75
SD	5.281	Std. Error of Mean	1.181
Coefficient of Variation	0.192	Skewness	0.219

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.932	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.154	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	29.54	95% Adjusted-CLT UCL (Chen-1995)	29.5
		95% Modified-t UCL (Johnson-1978)	29.55

Gamma GOF Test

A-D Test Statistic	0.507	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.15	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	28.56	k star (bias corrected MLE)	24.31
Theta hat (MLE)	0.963	Theta star (bias corrected MLE)	1.131
nu hat (MLE)	1142	nu star (bias corrected)	972.3
MLE Mean (bias corrected)	27.5	MLE Sd (bias corrected)	5.578
		Approximate Chi Square Value (0.05)	900.9
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	895.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	29.68	95% Adjusted Gamma UCL (use when n<50)	29.86

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.142	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.009	Mean of logged Data	3.297
Maximum of Logged Data	3.605	SD of logged Data	0.193

Assuming Lognormal Distribution

95% H-UCL	29.78	90% Chebyshev (MVUE) UCL	31.08
95% Chebyshev (MVUE) UCL	32.7	97.5% Chebyshev (MVUE) UCL	34.95
99% Chebyshev (MVUE) UCL	39.37		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	29.44	95% Jackknife UCL	29.54
95% Standard Bootstrap UCL	29.39	95% Bootstrap-t UCL	29.67
95% Hall's Bootstrap UCL	29.41	95% Percentile Bootstrap UCL	29.38
95% BCA Bootstrap UCL	29.42		
90% Chebyshev(Mean, Sd) UCL	31.04	95% Chebyshev(Mean, Sd) UCL	32.65
97.5% Chebyshev(Mean, Sd) UCL	34.87	99% Chebyshev(Mean, Sd) UCL	39.25

Suggested UCL to Use

95% Student's-t UCL 29.54

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (µg/L)

General Statistics

Total Number of Observations	20	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	1400	Mean	2154
Maximum	2947	Median	2095
SD	428.3	Std. Error of Mean	95.76
Coefficient of Variation	0.199	Skewness	0.414

Normal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.106	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2320	95% Adjusted-CLT UCL (Chen-1995)	2321
		95% Modified-t UCL (Johnson-1978)	2321

Gamma GOF Test

A-D Test Statistic	0.22	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0808	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.193	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	26.94	k star (bias corrected MLE)	22.93
Theta hat (MLE)	79.97	Theta star (bias corrected MLE)	93.94
nu hat (MLE)	1078	nu star (bias corrected)	917.3
MLE Mean (bias corrected)	2154	MLE Sd (bias corrected)	449.9
		Approximate Chi Square Value (0.05)	848
Adjusted Level of Significance	0.038	Adjusted Chi Square Value	842.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2330	95% Adjusted Gamma UCL (use when n<50)	2345

Appendix F3, Table 7. ProUCL Output - Beaver Creek Mine Discharge

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.905	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0786	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.192	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	7.244	Mean of logged Data	7.657
Maximum of Logged Data	7.989	SD of logged Data	0.199

Assuming Lognormal Distribution

95% H-UCL	2339	90% Chebyshev (MVUE) UCL	2443
95% Chebyshev (MVUE) UCL	2574	97.5% Chebyshev (MVUE) UCL	2756
99% Chebyshev (MVUE) UCL	3112		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2312	95% Jackknife UCL	2320
95% Standard Bootstrap UCL	2305	95% Bootstrap-t UCL	2335
95% Hall's Bootstrap UCL	2313	95% Percentile Bootstrap UCL	2307
95% BCA Bootstrap UCL	2316		
90% Chebyshev(Mean, Sd) UCL	2442	95% Chebyshev(Mean, Sd) UCL	2572
97.5% Chebyshev(Mean, Sd) UCL	2752	99% Chebyshev(Mean, Sd) UCL	3107

Suggested UCL to Use

95% Student's-t UCL 2320

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F4, Table 1. Comparison of Non-carcinogenic Hazard Estimates for Tribal Lifeway based on Alternative Food Ingestion Rates

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Receptor	Aquatic Biota Final COCs	Target Organ	Hazard Quotient									
			Tribal Lifeway [a]					Alternative Tribal Lifeway Food Ingestion Rates [b,c]				
		Ingestion/Dermal	Fish Tissue	Shellfish Tissue	Amphibian/Aquatic Reptile Tissue	Semi-Aquatic Mammals Tissue	Aquatic Plant (as food)	Fish Tissue	Shellfish Tissue	Amphibian/Aquatic Reptile Tissue	Semi-Aquatic Mammals Tissue	Aquatic Plant (as food)
			Ingestion	Ingestion	Ingestion	Ingestion	Ingestion	Ingestion	Ingestion	Ingestion	Ingestion	Ingestion
Adult [b]	Barium	Urinary	1.6E-02	2.2E-01	7.7E-03	5.3E-04	2.0E-01	1.6E-02	2.2E-01	7.7E-03	5.3E-04	5.0E-01
	Cadmium (non-water)	Urinary	8.5E-02	2.7E-01	2.0E-02	4.6E-02	2.8E+01	8.5E-02	2.7E-01	2.0E-02	4.6E-02	7.1E+01
	Copper	Gastrointestinal	1.8E-02	3.3E-02	5.0E-03	3.6E-02	9.1E-01	1.8E-02	3.3E-02	5.0E-03	3.6E-02	2.3E+00
	Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nickel	Whole Body	5.9E-03	8.3E-03	2.2E-03	1.8E-02	1.6E-01	5.9E-03	8.3E-03	2.2E-03	1.8E-02	4.0E-01
	Silver	Dermal	6.7E-02	6.2E-02	1.4E-02	NA	6.5E-02	6.7E-02	6.2E-02	1.4E-02	NA	1.6E-01
	Zinc	Immune, Hematologic	1.3E-01	6.6E-01	3.1E-02	1.5E-01	9.1E+00	1.3E-01	6.6E-01	3.1E-02	1.5E-01	2.3E+01
	Exposure Point Total		0.3	1	0.08	0.3	39	0.3	1	0.08	0.3	97
	Exposure Medium Total					2	39				2	97
	Medium Total						41					99
	Target Organ-Specific HI					Total Dermal HI =	0.2				Total Dermal HI =	0.3
						Total Gastrointestinal HI =	1				Total Gastrointestinal HI =	2
						Total Hematologic HI =	10				Total Hematologic HI =	24
						Total Immune HI =	10				Total Immune HI =	24
						Total Urinary HI =	29				Total Urinary HI =	72
						Total Whole Body HI =	0.2				Total Whole Body HI =	0.4
Child [c]	Barium	Urinary	3.7E-02	5.1E-01	1.8E-02	1.2E-03	4.6E-01	5.5E-02	7.5E-01	2.7E-02	1.8E-03	1.7E+00
	Cadmium (non-water)	Urinary	2.0E-01	6.4E-01	4.8E-02	1.1E-01	6.6E+01	2.9E-01	9.4E-01	7.0E-02	1.6E-01	2.5E+02
	Copper	Gastrointestinal	4.2E-02	7.8E-02	1.2E-02	8.4E-02	2.1E+00	6.2E-02	1.1E-01	1.7E-02	1.2E-01	7.9E+00
	Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Nickel	Whole Body	1.4E-02	1.9E-02	5.2E-03	4.3E-02	3.8E-01	2.1E-02	2.9E-02	7.7E-03	6.3E-02	1.4E+00
	Silver	Dermal	1.6E-01	1.4E-01	3.2E-02	NA	1.5E-01	2.3E-01	2.1E-01	4.7E-02	NA	5.6E-01
	Zinc	Immune, Hematologic	3.0E-01	1.5E+00	7.2E-02	3.5E-01	2.1E+01	4.4E-01	2.3E+00	1.1E-01	5.2E-01	7.9E+01
	Exposure Point Total		0.7	3	0.2	0.6	91	1	4	0.3	0.9	337
	Exposure Medium Total					4	91				7	337
	Medium Total						96					344
	Target Organ-Specific HI					Total Dermal HI =	0.5				Total Dermal HI =	1
						Total Gastrointestinal HI =	2				Total Gastrointestinal HI =	8
						Total Hematologic HI =	24				Total Hematologic HI =	82
						Total Immune HI =	24				Total Immune HI =	82
						Total Urinary HI =	68				Total Urinary HI =	250
						Total Whole Body HI =	0.5				Total Whole Body HI =	2

Notes:

[a] Tribal lifeway results presented in Appendix B Table 10s.

[b] Alternative food ingestion rates for Tribal Lifeway adults based on aquatic plant ingestion rate of 333 g/day.

[c] Child ingestion rates are assumed to be 74% of adult ingestion rates for Tribal Lifeway alternative food ingestion rate analysis.

HI = hazard index

NA = not available

COC = chemical of concern

Appendix F5, Table 1. Summary of Watershed-specific Receptor Hazards for Biota Consumption COCs (Adult)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Exposure Point	Chemical of Potential Concern	EPC (mg/kg)							RfD (mg/kg-day)	Hazard Quotient							Primary Target Organ
		Sitewide	EC	TC	NR	BC	LC	LSR		Sitewide	EC	TC	NR	BC	LC	LSR	
Fish Tissue	Barium	2.5E+00	3.5E+00	1.6E+00	3.9E+00	4.6E+00	5.4E+00	3.5E+00	2.0E-01	1.6E-02	2.2E-02	1.0E-02	2.5E-02	2.9E-02	3.4E-02	2.2E-02	Urinary
	Cadmium	6.6E-02	7.1E-02	8.8E-02	4.6E-02	9.5E-02	9.2E-02	8.1E-02	1.0E-03	8.5E-02	9.2E-02	1.1E-01	5.9E-02	1.2E-01	1.2E-01	1.0E-01	Urinary
	Copper	5.6E-01	5.0E-01	4.3E-01	5.3E-01	1.0E+00	1.5E+00	6.6E-01	4.0E-02	1.8E-02	1.6E-02	1.4E-02	1.7E-02	3.2E-02	4.9E-02	2.1E-02	Gastrointestinal
	Nickel	9.2E-02	8.0E-02	1.7E-01	8.1E-02	1.1E-01	1.4E-01	8.8E-02	2.0E-02	5.9E-03	5.1E-03	1.1E-02	5.2E-03	7.0E-03	9.1E-03	5.7E-03	Whole Body
	Silver	2.6E-01	1.9E-01	2.2E-01	2.4E-01	4.1E-01	3.1E-01	4.7E-01	5.0E-03	6.7E-02	4.9E-02	5.6E-02	6.1E-02	1.1E-01	8.1E-02	1.2E-01	Dermal
	Zinc	3.0E+01	3.0E+01	5.9E+01	2.3E+01	2.7E+01	2.2E+01	3.3E+01	3.0E-01	1.3E-01	1.3E-01	2.5E-01	1.0E-01	1.2E-01	9.2E-02	1.4E-01	Immune, Hematologic
Exposure Point Total										0.3	0.3	0.5	0.3	0.4	0.4	0.4	
Shellfish Tissue	Barium	1.0E+02	--	--	9.2E+01	--	--	7.0E+01	2.0E-01	2.2E-01	--	--	2.0E-01	--	--	1.5E-01	Urinary
	Cadmium	6.4E-01	--	--	2.2E-01	--	--	6.6E-01	1.0E-03	2.7E-01	--	--	9.4E-02	--	--	2.8E-01	Urinary
	Copper	3.1E+00	--	--	1.5E+00	--	--	3.2E+00	4.0E-02	3.3E-02	--	--	1.6E-02	--	--	3.4E-02	Gastrointestinal
	Nickel	3.9E-01	--	--	2.2E-01	--	--	4.0E-01	2.0E-02	8.3E-03	--	--	4.7E-03	--	--	8.6E-03	Whole Body
	Silver	7.2E-01	--	--	7.0E-01	--	--	7.2E-01	5.0E-03	6.2E-02	--	--	6.0E-02	--	--	6.2E-02	Dermal
	Zinc	4.6E+02	--	--	2.2E+02	--	--	4.7E+02	3.0E-01	6.6E-01	--	--	3.1E-01	--	--	6.8E-01	Immune, Hematologic
Exposure Point Total										1	0.0	0.0	0.7	0.0	0.0	1	
Aquatic Plant (as Food)	Barium	2.1E+01	9.3E+00	3.1E+01	8.0E+00	--	3.2E+01	2.8E+01	2.0E-01	2.0E-01	8.8E-02	2.9E-01	7.6E-02	--	3.0E-01	2.7E-01	Urinary
	Cadmium	1.5E+01	2.1E+01	5.5E+00	8.0E-02	--	3.0E-01	2.1E+00	1.0E-03	2.8E+01	4.0E+01	1.0E+01	1.5E-01	--	5.7E-01	4.0E+00	Urinary
	Copper	1.9E+01	2.3E+01	4.8E-01	1.3E+00	--	3.6E+00	2.1E+00	4.0E-02	9.1E-01	1.1E+00	2.3E-02	6.2E-02	--	1.7E-01	9.9E-02	Gastrointestinal
	Nickel	1.7E+00	3.6E+00	7.4E-01	2.8E-01	--	1.7E+00	2.3E+00	2.0E-02	1.6E-01	3.4E-01	7.0E-02	2.7E-02	--	1.6E-01	2.2E-01	Whole Body
	Silver	1.7E-01	--	--	--	--	1.7E-01	--	5.0E-03	6.5E-02	--	--	--	--	6.5E-02	--	Dermal
	Zinc	1.4E+03	1.8E+03	8.2E+02	8.9E+00	--	3.8E+01	3.7E+02	3.0E-01	9.1E+00	1.2E+01	5.2E+00	5.6E-02	--	2.4E-01	2.3E+00	Immune, Hematologic
Exposure Point Total										**39**	**53**	**16**	0.4	0	**2**	**7**	
Aquatic Plant (as Salve)	Barium	2.0E+01	9.3E+00	3.1E+01	--	--	1.5E+01	2.8E+01	1.4E-02	--	--	--	--	--	--	--	Urinary
	Cadmium	2.1E+01	2.1E+01	7.3E-01	--	--	3.6E-01	2.1E+00	2.5E-05	6.7E-03	6.7E-03	2.3E-04	--	--	1.1E-04	6.8E-04	Urinary
	Copper	2.3E+01	2.3E+01	4.8E-01	--	--	1.9E+00	2.1E+00	4.0E-02	--	--	--	--	--	--	--	Gastrointestinal
	Nickel	1.9E+00	3.6E+00	7.4E-01	--	--	5.4E-01	2.3E+00	8.0E-04	--	--	--	--	--	--	--	Whole Body
	Zinc	1.8E+03	1.8E+03	5.1E+01	--	--	4.8E+01	3.7E+02	3.0E-01	--	--	--	--	--	--	--	Immune, Hematologic
Exposure Point Total										0.007	0.007	0.0002	0	0	0.0001	0.0007	
Amphibian/Aquatic Reptile Tissue	Barium	4.5E+00	--	1.7E+00	4.8E+00	5.7E+00	1.2E+00	5.5E+00	2.0E-01	7.7E-03	--	3.0E-03	8.2E-03	9.8E-03	2.1E-03	9.4E-03	Urinary
	Cadmium	5.9E-02	--	6.0E-02	9.0E-02	1.0E-01	--	5.0E-02	1.0E-03	2.0E-02	--	2.1E-02	3.1E-02	3.4E-02	--	1.7E-02	Urinary
	Copper	5.8E-01	--	7.0E-01	1.2E+00	--	3.8E-01	5.8E-01	4.0E-02	5.0E-03	--	6.0E-03	1.0E-02	--	3.3E-03	5.0E-03	Gastrointestinal
	Nickel	1.3E-01	--	--	1.0E-01	--	--	1.3E-01	2.0E-02	2.2E-03	--	--	1.7E-03	--	--	2.2E-03	Whole Body
	Silver	2.0E-01	--	1.4E-01	--	--	--	3.5E-01	5.0E-03	1.4E-02	--	9.6E-03	--	--	--	2.4E-02	Dermal
	Zinc	2.7E+01	--	4.2E+01	1.6E+01	4.1E+01	7.4E+00	2.1E+01	3.0E-01	3.1E-02	--	4.7E-02	1.8E-02	4.7E-02	8.5E-03	2.4E-02	Immune, Hematologic
Exposure Point Total										0.08	0	0.09	0.07	0.09	0.01	0.08	

Appendix F5, Table 1. Summary of Watershed-specific Receptor Hazards for Biota Consumption COCs (Adult)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Adult

Exposure Point	Chemical of Potential Concern	EPC (mg/kg)							RfD (mg/kg-day)	Hazard Quotient							Primary Target Organ
		Sitewide	EC	TC	NR	BC	LC	LSR		Sitewide	EC	TC	NR	BC	LC	LSR	
Aquatic Mammals Tissue	Barium	1.1E-01	5.0E-02	--	1.0E-01	2.4E-01	8.0E-02	5.0E-02	2.0E-01	5.3E-04	2.5E-04	--	4.9E-04	1.2E-03	3.9E-04	2.5E-04	Urinary
	Cadmium	4.7E-02	8.0E-02	--	9.0E-02	4.0E-02	6.0E-02	4.0E-02	1.0E-03	4.6E-02	7.9E-02	--	8.9E-02	3.9E-02	5.9E-02	3.9E-02	Urinary
	Copper	1.5E+00	--	1.1E+00	2.0E+00	1.7E+00	2.2E+00	1.6E+00	4.0E-02	3.6E-02	--	2.7E-02	4.9E-02	4.2E-02	5.3E-02	3.9E-02	Gastrointestinal
	Nickel	3.7E-01	--	--	3.7E-01	--	--	--	2.0E-02	1.8E-02	--	--	1.8E-02	--	--	--	Whole Body
	Zinc	4.6E+01	6.1E+01	3.9E+01	5.5E+01	4.4E+01	4.5E+01	5.1E+01	3.0E-01	1.5E-01	2.0E-01	1.3E-01	1.8E-01	1.4E-01	1.5E-01	1.7E-01	Immune, Hematologic
Exposure Point Total										0.3	0.3	0.2	0.3	0.2	0.3	0.2	
Receptor Total										**41**	**54**	**17**	**2**	0.7	**2**	**9**	

Notes:

EPC = exposure point concentration

HI = hazard index

mg/kg = milligrams per kilogram

mg/kg/day = milligrams per kilogram per day

RfD = reference dose

Watersheds:

"Sitewide" = sitewide dataset including data from all six watersheds

EC = Elm Creek

TC = Tar Creek

NR = Neosho River

BC = Beaver Creek

LC = Lost Creek

LSR = Lower Spring River

	All	EC	TC	NR	BC	LC	LSR
Total Dermal HI Across Media =	0.2	0.05	0.07	0.1	0.1	0.1	0.2
Total Gastrointestinal HI Across Media =	1	1	0.07	0.2	0.07	0.3	0.2
Total Hematologic HI Across Media =	**10**	**12**	**6**	0.7	0.3	0.5	**3**
Total Immune HI Across Media =	**10**	**12**	**6**	0.7	0.3	0.5	**3**
Total Urinary HI Across Media =	**29**	**41**	**11**	0.7	0.2	1	**5**
Total Whole Body HI Across Media =	0.2	0.3	0.08	0.06	0.007	0.2	0.2

Appendix F5, Table 2. Summary of Watershed-specific Receptor Hazards for Biota Consumption COCs (Child)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Exposure Point	Chemical of Potential Concern	EPC (mg/kg)							RfD (mg/kg-day)	Hazard Quotient							Primary Target Organ
		Sitewide	EC	TC	NR	BC	LC	LSR		Sitewide	EC	TC	NR	BC	LC	LSR	
Fish Tissue	Barium	2.5E+00	3.5E+00	1.6E+00	3.9E+00	4.6E+00	5.4E+00	3.5E+00	2.0E-01	3.7E-02	5.2E-02	2.4E-02	5.9E-02	6.9E-02	8.0E-02	5.2E-02	Urinary
	Cadmium	6.6E-02	7.1E-02	8.8E-02	4.6E-02	9.5E-02	9.2E-02	8.1E-02	1.0E-03	2.0E-01	2.1E-01	2.6E-01	1.4E-01	2.8E-01	2.8E-01	2.4E-01	Urinary
	Copper	5.6E-01	5.0E-01	4.3E-01	5.3E-01	1.0E+00	1.5E+00	6.6E-01	4.0E-02	4.2E-02	3.7E-02	3.2E-02	4.0E-02	7.5E-02	1.1E-01	4.9E-02	Gastrointestinal
	Nickel	9.2E-02	8.0E-02	1.7E-01	8.1E-02	1.1E-01	1.4E-01	8.8E-02	2.0E-02	1.4E-02	1.2E-02	2.6E-02	1.2E-02	1.6E-02	2.1E-02	1.3E-02	Whole Body
	Silver	2.6E-01	1.9E-01	2.2E-01	2.4E-01	4.1E-01	3.1E-01	4.7E-01	5.0E-03	1.6E-01	1.1E-01	1.3E-01	1.4E-01	2.5E-01	1.9E-01	2.8E-01	Dermal
	Zinc	3.0E+01	3.0E+01	5.9E+01	2.3E+01	2.7E+01	2.2E+01	3.3E+01	3.0E-01	3.0E-01	3.0E-01	5.9E-01	2.3E-01	2.7E-01	2.2E-01	3.3E-01	Immune, Hematologic
Exposure Point Total										0.7	0.7	1	0.6	1	0.9	1	
Shellfish Tissue	Barium	1.0E+02	--	--	9.2E+01	--	--	7.0E+01	2.0E-01	5.1E-01	--	--	4.6E-01	--	--	3.5E-01	Urinary
	Cadmium	6.4E-01	--	--	2.2E-01	--	--	6.6E-01	1.0E-03	6.4E-01	--	--	2.2E-01	--	--	6.6E-01	Urinary
	Copper	3.1E+00	--	--	1.5E+00	--	--	3.2E+00	4.0E-02	7.8E-02	--	--	3.8E-02	--	--	7.9E-02	Gastrointestinal
	Nickel	3.9E-01	--	--	2.2E-01	--	--	4.0E-01	2.0E-02	1.9E-02	--	--	1.1E-02	--	--	2.0E-02	Whole Body
	Silver	7.2E-01	--	--	7.0E-01	--	--	7.2E-01	5.0E-03	1.4E-01	--	--	1.4E-01	--	--	1.4E-01	Dermal
	Zinc	4.6E+02	--	--	2.2E+02	--	--	4.7E+02	3.0E-01	1.5E+00	--	--	7.2E-01	--	--	1.6E+00	Immune, Hematologic
Exposure Point Total										**3**	0	0	**2**	0	0	**3**	
Aquatic Plant (as Food)	Barium	2.1E+01	9.3E+00	3.1E+01	8.0E+00	--	3.2E+01	2.8E+01	2.0E-01	4.6E-01	2.1E-01	6.9E-01	1.8E-01	--	7.1E-01	6.2E-01	Urinary
	Cadmium	1.5E+01	2.1E+01	5.5E+00	8.0E-02	--	3.0E-01	2.1E+00	1.0E-03	6.6E+01	9.4E+01	2.4E+01	3.5E-01	--	1.3E+00	9.4E+00	Urinary
	Copper	1.9E+01	2.3E+01	4.8E-01	1.3E+00	--	3.6E+00	2.1E+00	4.0E-02	2.1E+00	2.5E+00	5.3E-02	1.4E-01	--	3.9E-01	2.3E-01	Gastrointestinal
	Nickel	1.7E+00	3.6E+00	7.4E-01	2.8E-01	--	1.7E+00	2.3E+00	2.0E-02	3.8E-01	7.9E-01	1.6E-01	6.2E-02	--	3.7E-01	5.1E-01	Whole Body
	Silver	1.7E-01	--	--	--	--	1.7E-01	--	5.0E-03	1.5E-01	--	--	--	--	1.5E-01	--	Dermal
	Zinc	1.4E+03	1.8E+03	8.2E+02	8.9E+00	--	3.8E+01	3.7E+02	3.0E-01	2.1E+01	2.7E+01	1.2E+01	1.3E-01	--	5.7E-01	5.4E+00	Immune, Hematologic
Exposure Point Total										**91**	**125**	**37**	0.9	0	**4**	**16**	
Aquatic Plant (as Salve)	Barium	2.0E+01	9.3E+00	3.1E+01	--	--	1.5E+01	2.8E+01	1.4E-02	--	--	--	--	--	--	--	Urinary
	Cadmium	2.1E+01	2.1E+01	7.3E-01	--	--	3.6E-01	2.1E+00	2.5E-05	9.5E-03	9.5E-03	3.3E-04	--	--	1.6E-04	9.6E-04	Urinary
	Copper	2.3E+01	2.3E+01	4.8E-01	--	--	1.9E+00	2.1E+00	4.0E-02	--	--	--	--	--	--	--	Gastrointestinal
	Nickel	1.9E+00	3.6E+00	7.4E-01	--	--	5.4E-01	2.3E+00	8.0E-04	--	--	--	--	--	--	--	Whole Body
	Zinc	1.8E+03	1.8E+03	5.1E+01	--	--	4.8E+01	3.7E+02	3.0E-01	--	--	--	--	--	--	--	Immune, Hematologic
Exposure Point Total										0.01	0.01	0.0003	0	0	0.0002	0.001	
Amphibian/Aquatic Reptile Tissue	Barium	4.5E+00	--	1.7E+00	4.8E+00	5.7E+00	1.2E+00	5.5E+00	2.0E-01	1.8E-02	--	7.0E-03	1.9E-02	2.3E-02	5.0E-03	2.2E-02	Urinary
	Cadmium	5.9E-02	--	6.0E-02	9.0E-02	1.0E-01	--	5.0E-02	1.0E-03	4.8E-02	--	4.8E-02	7.2E-02	8.0E-02	--	4.0E-02	Urinary
	Copper	5.8E-01	--	7.0E-01	1.2E+00	--	3.8E-01	5.8E-01	4.0E-02	1.2E-02	--	1.4E-02	2.4E-02	--	7.6E-03	1.2E-02	Gastrointestinal
	Nickel	1.3E-01	--	--	1.0E-01	--	--	1.3E-01	2.0E-02	5.2E-03	--	--	4.0E-03	--	--	5.2E-03	Whole Body
	Silver	2.0E-01	--	1.4E-01	--	--	--	3.5E-01	5.0E-03	3.2E-02	--	2.2E-02	--	--	--	5.6E-02	Dermal
	Zinc	2.7E+01	--	4.2E+01	1.6E+01	4.1E+01	7.4E+00	2.1E+01	3.0E-01	7.2E-02	--	1.1E-01	4.3E-02	1.1E-01	2.0E-02	5.5E-02	Immune, Hematologic
Exposure Point Total										0.2	0	0.2	0.2	0.2	0.03	0.2	

Appendix F5, Table 2. Summary of Watershed-specific Receptor Hazards for Biota Consumption COCs (Child)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Scenario Timeframe: Current/Future
Receptor Population: Tribal Lifeway
Receptor Age: Child

Exposure Point	Chemical of Potential Concern	EPC (mg/kg)							RfD (mg/kg-day)	Hazard Quotient							Primary Target Organ
		Sitewide	EC	TC	NR	BC	LC	LSR		Sitewide	EC	TC	NR	BC	LC	LSR	
Aquatic Mammals Tissue	Barium	1.1E-01	5.0E-02	--	1.0E-01	2.4E-01	8.0E-02	5.0E-02	2.0E-01	1.2E-03	5.8E-04	--	1.2E-03	2.8E-03	9.2E-04	5.8E-04	Urinary
	Cadmium	4.7E-02	8.0E-02	--	9.0E-02	4.0E-02	6.0E-02	4.0E-02	1.0E-03	1.1E-01	1.8E-01	--	2.1E-01	9.2E-02	1.4E-01	9.2E-02	Urinary
	Copper	1.5E+00	--	1.1E+00	2.0E+00	1.7E+00	2.2E+00	1.6E+00	4.0E-02	8.4E-02	--	6.3E-02	1.1E-01	9.7E-02	1.2E-01	9.0E-02	Gastrointestinal
	Nickel	3.7E-01	--	--	3.7E-01	--	--	--	2.0E-02	4.3E-02	--	--	4.3E-02	--	--	--	Whole Body
	Zinc	4.6E+01	6.1E+01	3.9E+01	5.5E+01	4.4E+01	4.5E+01	5.1E+01	3.0E-01	3.5E-01	4.7E-01	3.0E-01	4.2E-01	3.4E-01	3.5E-01	3.9E-01	Immune, Hematologic
Exposure Point Total										0.6	0.7	0.4	0.8	0.5	0.6	0.6	
Receptor Total										**95**	**126**	**39**	**4**	**2**	**5**	**21**	

Notes:

EPC = exposure point concentration

HI = hazard index

mg/kg = milligrams per kilogram

mg/kg/day = milligrams per kilogram per day

RfD = reference dose

Watersheds:

"Sitewide" = sitewide dataset including data from all six watersheds

EC = Elm Creek

TC = Tar Creek

NR = Neosho River

BC = Beaver Creek

LC = Lost Creek

LSR = Lower Spring River

	All	EC	TC	NR	BC	LC	LSR
Total Dermal HI Across Media =	0.5	0.1	0.2	0.3	0.2	0.3	0.5
Total Gastrointestinal HI Across Media =	**2**	**3**	0.2	0.4	0.2	0.6	0.5
Total Hematologic HI Across Media =	**24**	**28**	**13**	**2**	0.7	1	**8**
Total Immune HI Across Media =	**24**	**28**	**13**	**2**	0.7	1	**8**
Total Urinary HI Across Media =	**68**	**95**	**25**	**2**	0.6	**3**	**12**
Total Whole Body HI Across Media =	0.5	0.8	0.2	0.1	0.02	0.4	0.6

Appendix F5, Table 3. Summary of Receptor Hazards for Final Watershed Specific Biota COCs - Tribal Lifeway Child [a]

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Exposure Medium	Exposure Point	Exposure Route	Elm Creek	% [c] contribution	Tar Creek	% [c] contribution	Lower Spring River	% [c] contribution
Non-Carcinogenic Hazard Index [b]								
Aquatic Biota Animal/Plant	Shellfish	Ingestion	NA		NA		3	15%
	Aquatic Plant (food)	Ingestion	124	100%	37	100%	16	85%
	Total (Biota) [c]		124	100%	37	100%	19	100%
	Target Organ-Specific Total HI	Dermal	NA		NA		≤ 1	
		Gastrointestinal	3		≤ 1		≤ 1	
		Hematologic	27		12		7	
		Immune	27		12		7	
		Urinary	94		24		11	
		Whole Body	NA		≤ 1		≤ 1	
	Final Biota COCs [b]		Cadmium	76%	Cadmium	66%	Barium	5.1%
			Copper	2.0%	Copper	0.1%	Cadmium	53%
			Zinc	22%	Nickel	0.4%	Copper	1.6%
					Silver	NA	Nickel	2.8%
					Zinc	33%	Silver	0.8%
							Zinc	37%
Total (Receptor) [c]			124	100%	37	100%	19	100%

Notes:

[a] Because the child exposure scenario yields higher non-carcinogenic HI than the adult exposure scenario, a summary of non-carcinogenic HI for the final COCs is presented for child exposure scenario.

[b] The lists of final COCs on this table do not include lead. The evaluation of lead exposure was performed in Appendix E. Final COCs for each watershed are based on Table 5-12. Although Neosho River has HI>1 for shellfish and Lost Creek has HI>1 for aquatic plants, when considering only the final COCs for these watersheds, the HIs are less than 1 for all target organs.

[c] Percent (%) contribution for each exposure route and total (exposure medium) is calculated as percentage of total (receptor) HI. Percent contribution for final COC is calculated on an exposure medium basis as percentage of total (exposure medium).

Acronyms:

COC = chemical of concern

HI = hazard index

NA = not applicable; target organ is not associated with the final COCs

Appendix F5, Table 4. ProUCL Output - Whole Fish Tissue (Elm Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 3:12:53 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Barium (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	0.326	Mean	1.851
Maximum	8.579	Median	1.485
SD	1.768	Std. Error of Mean	0.377
Coefficient of Variation	0.955	Skewness	3.092

Normal GOF Test

Shapiro Wilk Test Statistic	0.605	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.333	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.5	95% Adjusted-CLT UCL (Chen-1995)	2.737
		95% Modified-t UCL (Johnson-1978)	2.541

Gamma GOF Test

A-D Test Statistic	1.368	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.756	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.246	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.188	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.077	k star (bias corrected MLE)	1.824
Theta hat (MLE)	0.891	Theta star (bias corrected MLE)	1.015
nu hat (MLE)	91.37	nu star (bias corrected)	80.24
MLE Mean (bias corrected)	1.851	MLE Sd (bias corrected)	1.371
		Approximate Chi Square Value (0.05)	60.6
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	59.33

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.451	95% Adjusted Gamma UCL (use when n<50)	2.504

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.908	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.193	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.122	Mean of logged Data	0.356
Maximum of Logged Data	2.149	SD of logged Data	0.7

Assuming Lognormal Distribution

95% H-UCL	2.552	90% Chebyshev (MVUE) UCL	2.661
95% Chebyshev (MVUE) UCL	3.052	97.5% Chebyshev (MVUE) UCL	3.594
99% Chebyshev (MVUE) UCL	4.658		

Appendix F5, Table 4. ProUCL Output - Whole Fish Tissue (Elm Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2.471	95% Jackknife UCL	2.5
95% Standard Bootstrap UCL	2.457	95% Bootstrap-t UCL	3.649
95% Hall's Bootstrap UCL	5.853	95% Percentile Bootstrap UCL	2.513
95% BCA Bootstrap UCL	2.778		
90% Chebyshev(Mean, Sd) UCL	2.982	95% Chebyshev(Mean, Sd) UCL	3.494
97.5% Chebyshev(Mean, Sd) UCL	4.205	99% Chebyshev(Mean, Sd) UCL	5.601

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	3.494

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	0.042	Mean	0.0649
Maximum	0.103	Median	0.0657
SD	0.0173	Std. Error of Mean	0.00369
Coefficient of Variation	0.267	Skewness	0.688

Normal GOF Test

Shapiro Wilk Test Statistic	0.935	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.122	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.0712	95% Adjusted-CLT UCL (Chen-1995)	0.0715
		95% Modified-t UCL (Johnson-1978)	0.0713

Gamma GOF Test

A-D Test Statistic	0.336	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.116	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.185	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	15.39	k star (bias corrected MLE)	13.32
Theta hat (MLE)	0.00422	Theta star (bias corrected MLE)	0.00487
nu hat (MLE)	677	nu star (bias corrected)	586
MLE Mean (bias corrected)	0.0649	MLE Sd (bias corrected)	0.0178
		Approximate Chi Square Value (0.05)	530.8
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	526.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.0716	95% Adjusted Gamma UCL (use when n<50)	0.0722

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.117	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-3.17	Mean of logged Data	-2.768
Maximum of Logged Data	-2.269	SD of logged Data	0.261

Assuming Lognormal Distribution

95% H-UCL	0.072	90% Chebyshev (MVUE) UCL	0.0758
95% Chebyshev (MVUE) UCL	0.0808	97.5% Chebyshev (MVUE) UCL	0.0876
99% Chebyshev (MVUE) UCL	0.101		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.071	95% Jackknife UCL	0.0712
95% Standard Bootstrap UCL	0.0708	95% Bootstrap-t UCL	0.072
95% Hall's Bootstrap UCL	0.0722	95% Percentile Bootstrap UCL	0.0709
95% BCA Bootstrap UCL	0.0716		
90% Chebyshev(Mean, Sd) UCL	0.076	95% Chebyshev(Mean, Sd) UCL	0.081
97.5% Chebyshev(Mean, Sd) UCL	0.088	99% Chebyshev(Mean, Sd) UCL	0.102

Suggested UCL to Use

95% Student's-t UCL	0.0712

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
Number of Detects	17	Number of Non-Detects	5
Number of Distinct Detects	17	Number of Distinct Non-Detects	5
Minimum Detect	0.31	Minimum Non-Detect	0.254
Maximum Detect	0.783	Maximum Non-Detect	0.525
Variance Detects	0.0202	Percent Non-Detects	22.73%
Mean Detects	0.482	SD Detects	0.142
Median Detects	0.464	CV Detects	0.295
Skewness Detects	0.521	Kurtosis Detects	-0.723
Mean of Logged Detects	-0.771	SD of Logged Detects	0.292

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.18	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.207	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.439	KM Standard Error of Mean	0.033
KM SD	0.148	95% KM (BCA) UCL	0.499
95% KM (t) UCL	0.495	95% KM (Percentile Bootstrap) UCL	0.491
95% KM (z) UCL	0.493	95% KM Bootstrap t UCL	0.499
90% KM Chebyshev UCL	0.538	95% KM Chebyshev UCL	0.583
97.5% KM Chebyshev UCL	0.645	99% KM Chebyshev UCL	0.767

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.493	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.739	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.181	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.209	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	12.55	k star (bias corrected MLE)	10.38
Theta hat (MLE)	0.0384	Theta star (bias corrected MLE)	0.0464
nu hat (MLE)	426.9	nu star (bias corrected)	352.9
Mean (detects)	0.482		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.209	Mean	0.432
Maximum	0.783	Median	0.373
SD	0.159	CV	0.367
k hat (MLE)	7.669	k star (bias corrected MLE)	6.653
Theta hat (MLE)	0.0564	Theta star (bias corrected MLE)	0.065
nu hat (MLE)	337.4	nu star (bias corrected)	292.7
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (292.74, α)	254.1	Adjusted Chi Square Value (292.74, β)	251.4
95% Gamma Approximate UCL (use when n>=50)	0.498	95% Gamma Adjusted UCL (use when n<50)	0.503

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.439	SD (KM)	0.148
Variance (KM)	0.022	SE of Mean (KM)	0.033
k hat (KM)	8.746	k star (KM)	7.583
nu hat (KM)	384.8	nu star (KM)	333.7
theta hat (KM)	0.0502	theta star (KM)	0.0578
80% gamma percentile (KM)	0.564	90% gamma percentile (KM)	0.651
95% gamma percentile (KM)	0.729	99% gamma percentile (KM)	0.891

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (333.66, α)	292.3	Adjusted Chi Square Value (333.66, β)	289.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.501	95% Gamma Adjusted KM-UCL (use when n<50)	0.506

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.169	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.207	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.437	Mean in Log Scale	-0.885
SD in Original Scale	0.152	SD in Log Scale	0.346
95% t UCL (assumes normality of ROS data)	0.493	95% Percentile Bootstrap UCL	0.49
95% BCA Bootstrap UCL	0.491	95% Bootstrap t UCL	0.493
95% H-UCL (Log ROS)	0.505		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.88	KM Geo Mean	0.415
KM SD (logged)	0.334	95% Critical H Value (KM-Log)	1.862
KM Standard Error of Mean (logged)	0.0749	95% H-UCL (KM -Log)	0.502
KM SD (logged)	0.334	95% Critical H Value (KM-Log)	1.862
KM Standard Error of Mean (logged)	0.0749		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.414	Mean in Log Scale	-0.993
SD in Original Scale	0.181	SD in Log Scale	0.513
95% t UCL (Assumes normality)	0.48	95% H-Stat UCL	0.529

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.495

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	21
Number of Detects	16	Number of Non-Detects	6
Number of Distinct Detects	16	Number of Distinct Non-Detects	5
Minimum Detect	0.285	Minimum Non-Detect	0.23
Maximum Detect	0.616	Maximum Non-Detect	0.24
Variance Detects	0.00682	Percent Non-Detects	27.27%
Mean Detects	0.407	SD Detects	0.0826
Median Detects	0.402	CV Detects	0.203
Skewness Detects	0.91	Kurtosis Detects	1.7
Mean of Logged Detects	-0.918	SD of Logged Detects	0.197

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.938	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.171	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.359	KM Standard Error of Mean	0.0229
KM SD	0.104	95% KM (BCA) UCL	0.397
95% KM (t) UCL	0.398	95% KM (Percentile Bootstrap) UCL	0.396
95% KM (z) UCL	0.396	95% KM Bootstrap t UCL	0.401
90% KM Chebyshev UCL	0.427	95% KM Chebyshev UCL	0.458
97.5% KM Chebyshev UCL	0.502	99% KM Chebyshev UCL	0.587

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.27	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.143	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	27.29	k star (bias corrected MLE)	22.22
Theta hat (MLE)	0.0149	Theta star (bias corrected MLE)	0.0183
nu hat (MLE)	873.4	nu star (bias corrected)	711
Mean (detects)	0.407		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.21	Mean	0.359
Maximum	0.616	Median	0.375
SD	0.106	CV	0.294
k hat (MLE)	12.11	k star (bias corrected MLE)	10.49
Theta hat (MLE)	0.0297	Theta star (bias corrected MLE)	0.0343
nu hat (MLE)	533	nu star (bias corrected)	461.6
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (461.63, α)	412.8	Adjusted Chi Square Value (461.63, β)	409.4
95% Gamma Approximate UCL (use when n>=50)	0.402	95% Gamma Adjusted UCL (use when n<50)	0.405

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.359	SD (KM)	0.104
Variance (KM)	0.0108	SE of Mean (KM)	0.0229
k hat (KM)	11.85	k star (KM)	10.27
nu hat (KM)	521.5	nu star (KM)	451.7
theta hat (KM)	0.0303	theta star (KM)	0.0349
80% gamma percentile (KM)	0.448	90% gamma percentile (KM)	0.507
95% gamma percentile (KM)	0.56	99% gamma percentile (KM)	0.669

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (451.72, α)	403.4	Adjusted Chi Square Value (451.72, β)	400
95% Gamma Approximate KM-UCL (use when n>=50)	0.401	95% Gamma Adjusted KM-UCL (use when n<50)	0.405

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.134	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.365	Mean in Log Scale	-1.042
SD in Original Scale	0.099	SD in Log Scale	0.267
95% t UCL (assumes normality of ROS data)	0.401	95% Percentile Bootstrap UCL	0.399
95% BCA Bootstrap UCL	0.401	95% Bootstrap t UCL	0.404
95% H-UCL (Log ROS)	0.406		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.068	KM Geo Mean	0.344
KM SD (logged)	0.295	95% Critical H Value (KM-Log)	1.835
KM Standard Error of Mean (logged)	0.0649	95% H-UCL (KM -Log)	0.404
KM SD (logged)	0.295	95% Critical H Value (KM-Log)	1.835
KM Standard Error of Mean (logged)	0.0649		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.328	Mean in Log Scale	-1.252
SD in Original Scale	0.149	SD in Log Scale	0.582
95% t UCL (Assumes normality)	0.383	95% H-Stat UCL	0.441

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.398

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	11
Number of Detects	10	Number of Non-Detects	12
Number of Distinct Detects	10	Number of Distinct Non-Detects	1

Minimum Detect	0.0725	Minimum Non-Detect	0.07
Maximum Detect	0.112	Maximum Non-Detect	0.07
Variance Detects	1.3116E-4	Percent Non-Detects	54.55%
Mean Detects	0.0829	SD Detects	0.0115
Median Detects	0.0796	CV Detects	0.138
Skewness Detects	2.105	Kurtosis Detects	5.148
Mean of Logged Detects	-2.498	SD of Logged Detects	0.126

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.775	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.235	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.262	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0759	KM Standard Error of Mean	0.00219
KM SD	0.00974	95% KM (BCA) UCL	0.0798
95% KM (t) UCL	0.0796	95% KM (Percentile Bootstrap) UCL	0.0795
95% KM (z) UCL	0.0795	95% KM Bootstrap t UCL	0.0817
90% KM Chebyshev UCL	0.0824	95% KM Chebyshev UCL	0.0854
97.5% KM Chebyshev UCL	0.0895	99% KM Chebyshev UCL	0.0977

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.731	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.724	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.205	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	66.23	k star (bias corrected MLE)	46.43
Theta hat (MLE)	0.00125	Theta star (bias corrected MLE)	0.00179
nu hat (MLE)	1325	nu star (bias corrected)	928.5
Mean (detects)	0.0829		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0331	Mean	0.0662
Maximum	0.112	Median	0.0646
SD	0.0188	CV	0.284
k hat (MLE)	12.57	k star (bias corrected MLE)	10.89
Theta hat (MLE)	0.00526	Theta star (bias corrected MLE)	0.00608
nu hat (MLE)	553.1	nu star (bias corrected)	479
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (479.03, α)	429.3	Adjusted Chi Square Value (479.03, β)	425.8
95% Gamma Approximate UCL (use when n>=50)	0.0738	95% Gamma Adjusted UCL (use when n<50)	0.0744

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0759	SD (KM)	0.00974
Variance (KM)	9.4955E-5	SE of Mean (KM)	0.00219
k hat (KM)	60.61	k star (KM)	52.38
nu hat (KM)	2667	nu star (KM)	2305
theta hat (KM)	0.00125	theta star (KM)	0.00145
80% gamma percentile (KM)	0.0845	90% gamma percentile (KM)	0.0896
95% gamma percentile (KM)	0.0939	99% gamma percentile (KM)	0.102

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	2194	Adjusted Chi Square Value (N/A, β)	2186
95% Gamma Approximate KM-UCL (use when n>=50)	0.0797	95% Gamma Adjusted KM-UCL (use when n<50)	0.08

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.826	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.203	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.069	Mean in Log Scale	-2.699
SD in Original Scale	0.0159	SD in Log Scale	0.226
95% t UCL (assumes normality of ROS data)	0.0748	95% Percentile Bootstrap UCL	0.0751
95% BCA Bootstrap UCL	0.0747	95% Bootstrap t UCL	0.0752
95% H-UCL (Log ROS)	0.0754		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.586	KM Geo Mean	0.0753
KM SD (logged)	0.114	95% Critical H Value (KM-Log)	1.731
KM Standard Error of Mean (logged)	0.0256	95% H-UCL (KM -Log)	0.0792
KM SD (logged)	0.114	95% Critical H Value (KM-Log)	1.731
KM Standard Error of Mean (logged)	0.0256		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0568	Mean in Log Scale	-2.964
SD in Original Scale	0.0255	SD in Log Scale	0.443
95% t UCL (Assumes normality)	0.0661	95% H-Stat UCL	0.0688

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0796

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	16
Number of Detects	15	Number of Non-Detects	7
Number of Distinct Detects	15	Number of Distinct Non-Detects	1
Minimum Detect	0.166	Minimum Non-Detect	0.15
Maximum Detect	0.251	Maximum Non-Detect	0.15
Variance Detects	5.4354E-4	Percent Non-Detects	31.82%
Mean Detects	0.193	SD Detects	0.0233
Median Detects	0.195	CV Detects	0.121
Skewness Detects	1.016	Kurtosis Detects	1.244
Mean of Logged Detects	-1.652	SD of Logged Detects	0.116

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.907	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Appendix F5, Table 4. ProUCL Output - Whole Fish Tissue (Elm Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.179	KM Standard Error of Mean	0.00602
KM SD	0.0273	95% KM (BCA) UCL	0.189
95% KM (t) UCL	0.19	95% KM (Percentile Bootstrap) UCL	0.189
95% KM (z) UCL	0.189	95% KM Bootstrap t UCL	0.191
90% KM Chebyshev UCL	0.197	95% KM Chebyshev UCL	0.205
97.5% KM Chebyshev UCL	0.217	99% KM Chebyshev UCL	0.239

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.417	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.158	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.221	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	77.41	k star (bias corrected MLE)	61.97
Theta hat (MLE)	0.00249	Theta star (bias corrected MLE)	0.00311
nu hat (MLE)	2322	nu star (bias corrected)	1859
Mean (detects)	0.193		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.117	Mean	0.176
Maximum	0.251	Median	0.174
SD	0.0329	CV	0.187
k hat (MLE)	29.43	k star (bias corrected MLE)	25.45
Theta hat (MLE)	0.00596	Theta star (bias corrected MLE)	0.0069
nu hat (MLE)	1295	nu star (bias corrected)	1120
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (N/A, α)	1043	Adjusted Chi Square Value (N/A, β)	1038
95% Gamma Approximate UCL (use when n>=50)	0.188	95% Gamma Adjusted UCL (use when n<50)	0.189

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.179	SD (KM)	0.0273
Variance (KM)	7.4441E-4	SE of Mean (KM)	0.00602
k hat (KM)	43.15	k star (KM)	37.3
nu hat (KM)	1899	nu star (KM)	1641
theta hat (KM)	0.00415	theta star (KM)	0.00481
80% gamma percentile (KM)	0.203	90% gamma percentile (KM)	0.218
95% gamma percentile (KM)	0.23	99% gamma percentile (KM)	0.254

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	1548	Adjusted Chi Square Value (N/A, β)	1541
95% Gamma Approximate KM-UCL (use when n>=50)	0.19	95% Gamma Adjusted KM-UCL (use when n<50)	0.191

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.149	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.177	Mean in Log Scale	-1.745
SD in Original Scale	0.0308	SD in Log Scale	0.173
95% t UCL (assumes normality of ROS data)	0.188	95% Percentile Bootstrap UCL	0.188
95% BCA Bootstrap UCL	0.189	95% Bootstrap t UCL	0.189
95% H-UCL (Log ROS)	0.189		

Appendix F5, Table 4. ProUCL Output - Whole Fish Tissue (Elm Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.73	KM Geo Mean	0.177
KM SD (logged)	0.147	95% Critical H Value (KM-Log)	1.747
KM Standard Error of Mean (logged)	0.0325	95% H-UCL (KM -Log)	0.19
KM SD (logged)	0.147	95% Critical H Value (KM-Log)	1.747
KM Standard Error of Mean (logged)	0.0325		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.155	Mean in Log Scale	-1.951
SD in Original Scale	0.0593	SD in Log Scale	0.457
95% t UCL (Assumes normality)	0.177	95% H-Stat UCL	0.192

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.19

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	22	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	11.58	Mean	25.62
Maximum	62.25	Median	24.2
SD	10.98	Std. Error of Mean	2.341
Coefficient of Variation	0.429	Skewness	1.789

Normal GOF Test

Shapiro Wilk Test Statistic	0.85	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.184	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	29.65	95% Adjusted-CLT UCL (Chen-1995)	30.42
		95% Modified-t UCL (Johnson-1978)	29.8

Gamma GOF Test

A-D Test Statistic	0.444	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.144	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.186	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.806	k star (bias corrected MLE)	5.908
Theta hat (MLE)	3.765	Theta star (bias corrected MLE)	4.337
nu hat (MLE)	299.4	nu star (bias corrected)	259.9
MLE Mean (bias corrected)	25.62	MLE Sd (bias corrected)	10.54
		Approximate Chi Square Value (0.05)	223.6
Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	221.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	29.78	95% Adjusted Gamma UCL (use when n<50)	30.12

Appendix F5, Table 4. ProUCL Output - Whole Fish Tissue (Elm Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.156	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.184	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.449	Mean of logged Data	3.168
Maximum of Logged Data	4.131	SD of logged Data	0.391

Assuming Lognormal Distribution

95% H-UCL	30.18	90% Chebyshev (MVUE) UCL	32.11
95% Chebyshev (MVUE) UCL	35.08	97.5% Chebyshev (MVUE) UCL	39.2
99% Chebyshev (MVUE) UCL	47.29		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	29.47	95% Jackknife UCL	29.65
95% Standard Bootstrap UCL	29.4	95% Bootstrap-t UCL	31.17
95% Hall's Bootstrap UCL	36.15	95% Percentile Bootstrap UCL	29.39
95% BCA Bootstrap UCL	30.01		
90% Chebyshev(Mean, Sd) UCL	32.64	95% Chebyshev(Mean, Sd) UCL	35.82
97.5% Chebyshev(Mean, Sd) UCL	40.24	99% Chebyshev(Mean, Sd) UCL	48.91

Suggested UCL to Use

95% Adjusted Gamma UCL	30.12

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 3:19:38 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Barium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	0.178	Mean	1.218
Maximum	2.806	Median	1.33
SD	0.798	Std. Error of Mean	0.206
Coefficient of Variation	0.655	Skewness	0.305

Normal GOF Test

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.149	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.581	95% Adjusted-CLT UCL (Chen-1995)	1.574
		95% Modified-t UCL (Johnson-1978)	1.583

Gamma GOF Test

A-D Test Statistic	0.539	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.216	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.225	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.906	k star (bias corrected MLE)	1.569
Theta hat (MLE)	0.639	Theta star (bias corrected MLE)	0.776
nu hat (MLE)	57.17	nu star (bias corrected)	47.07
MLE Mean (bias corrected)	1.218	MLE Sd (bias corrected)	0.972
		Approximate Chi Square Value (0.05)	32.32
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	30.82

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.773	95% Adjusted Gamma UCL (use when n<50)	1.859

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.902	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.245	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.728	Mean of logged Data	-0.0878
Maximum of Logged Data	1.032	SD of logged Data	0.867

Assuming Lognormal Distribution

95% H-UCL	2.402	90% Chebyshev (MVUE) UCL	2.224
95% Chebyshev (MVUE) UCL	2.646	97.5% Chebyshev (MVUE) UCL	3.232
99% Chebyshev (MVUE) UCL	4.384		

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.557	95% Jackknife UCL	1.581
95% Standard Bootstrap UCL	1.538	95% Bootstrap-t UCL	1.595
95% Hall's Bootstrap UCL	1.582	95% Percentile Bootstrap UCL	1.556
95% BCA Bootstrap UCL	1.555		
90% Chebyshev(Mean, Sd) UCL	1.836	95% Chebyshev(Mean, Sd) UCL	2.116
97.5% Chebyshev(Mean, Sd) UCL	2.505	99% Chebyshev(Mean, Sd) UCL	3.268

Suggested UCL to Use

95% Student's-t UCL	1.581

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
Number of Detects	14	Number of Non-Detects	1
Number of Distinct Detects	14	Number of Distinct Non-Detects	1
Minimum Detect	0.0327	Minimum Non-Detect	0.03
Maximum Detect	0.128	Maximum Non-Detect	0.03
Variance Detects	0.00138	Percent Non-Detects	6.667%
Mean Detects	0.0735	SD Detects	0.0371
Median Detects	0.0656	CV Detects	0.505
Skewness Detects	0.384	Kurtosis Detects	-1.618
Mean of Logged Detects	-2.737	SD of Logged Detects	0.529

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.861	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.186	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0706	KM Standard Error of Mean	0.00971
KM SD	0.0362	95% KM (BCA) UCL	0.0859
95% KM (t) UCL	0.0877	95% KM (Percentile Bootstrap) UCL	0.0867
95% KM (z) UCL	0.0866	95% KM Bootstrap t UCL	0.0901
90% KM Chebyshev UCL	0.0997	95% KM Chebyshev UCL	0.113
97.5% KM Chebyshev UCL	0.131	99% KM Chebyshev UCL	0.167

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.638	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.74	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.174	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.23	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.124	k star (bias corrected MLE)	3.288
Theta hat (MLE)	0.0178	Theta star (bias corrected MLE)	0.0224
nu hat (MLE)	115.5	nu star (bias corrected)	92.07
Mean (detects)	0.0735		

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0693
Maximum	0.128	Median	0.0595
SD	0.0394	CV	0.568
k hat (MLE)	2.768	k star (bias corrected MLE)	2.259
Theta hat (MLE)	0.025	Theta star (bias corrected MLE)	0.0307
nu hat (MLE)	83.05	nu star (bias corrected)	67.77
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (67.77, α)	49.82	Adjusted Chi Square Value (67.77, β)	47.93
95% Gamma Approximate UCL (use when n>=50)	0.0942	95% Gamma Adjusted UCL (use when n<50)	0.0979

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0706	SD (KM)	0.0362
Variance (KM)	0.00131	SE of Mean (KM)	0.00971
k hat (KM)	3.795	k star (KM)	3.08
nu hat (KM)	113.8	nu star (KM)	92.4
theta hat (KM)	0.0186	theta star (KM)	0.0229
80% gamma percentile (KM)	0.1	90% gamma percentile (KM)	0.125
95% gamma percentile (KM)	0.147	99% gamma percentile (KM)	0.196

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (92.40, α)	71.24	Adjusted Chi Square Value (92.40, β)	68.95
95% Gamma Approximate KM-UCL (use when n>=50)	0.0916	95% Gamma Adjusted KM-UCL (use when n<50)	0.0946

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.885	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0698	Mean in Log Scale	-2.821
SD in Original Scale	0.0385	SD in Log Scale	0.606
95% t UCL (assumes normality of ROS data)	0.0873	95% Percentile Bootstrap UCL	0.0853
95% BCA Bootstrap UCL	0.0857	95% Bootstrap t UCL	0.0885
95% H-UCL (Log ROS)	0.102		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.788	KM Geo Mean	0.0616
KM SD (logged)	0.528	95% Critical H Value (KM-Log)	2.099
KM Standard Error of Mean (logged)	0.142	95% H-UCL (KM -Log)	0.0952
KM SD (logged)	0.528	95% Critical H Value (KM-Log)	2.099
KM Standard Error of Mean (logged)	0.142		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0696	Mean in Log Scale	-2.834
SD in Original Scale	0.0389	SD in Log Scale	0.634
95% t UCL (Assumes normality)	0.0873	95% H-Stat UCL	0.105

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0877

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
Number of Detects	4	Number of Non-Detects	11
Number of Distinct Detects	4	Number of Distinct Non-Detects	11
Minimum Detect	0.263	Minimum Non-Detect	0.293
Maximum Detect	0.924	Maximum Non-Detect	0.59
Variance Detects	0.0913	Percent Non-Detects	73.33%
Mean Detects	0.477	SD Detects	0.302
Median Detects	0.36	CV Detects	0.634
Skewness Detects	1.849	Kurtosis Detects	3.549
Mean of Logged Detects	-0.866	SD of Logged Detects	0.546

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.773	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.379	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Detected Data Not Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.338	KM Standard Error of Mean	0.0511
KM SD	0.163	95% KM (BCA) UCL	N/A
95% KM (t) UCL	0.428	95% KM (Percentile Bootstrap) UCL	N/A
95% KM (z) UCL	0.422	95% KM Bootstrap t UCL	N/A
90% KM Chebyshev UCL	0.491	95% KM Chebyshev UCL	0.561
97.5% KM Chebyshev UCL	0.657	99% KM Chebyshev UCL	0.847

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.519	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.366	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.175	k star (bias corrected MLE)	1.21
Theta hat (MLE)	0.114	Theta star (bias corrected MLE)	0.394
nu hat (MLE)	33.4	nu star (bias corrected)	9.684
Mean (detects)	0.477		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.164	Mean	0.294
Maximum	0.924	Median	0.249
SD	0.183	CV	0.622
k hat (MLE)	5.119	k star (bias corrected MLE)	4.14
Theta hat (MLE)	0.0574	Theta star (bias corrected MLE)	0.071
nu hat (MLE)	153.6	nu star (bias corrected)	124.2
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (124.19, α)	99.45	Adjusted Chi Square Value (124.19, β)	96.73
95% Gamma Approximate UCL (use when n>=50)	0.367	95% Gamma Adjusted UCL (use when n<50)	N/A

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.338	SD (KM)	0.163
Variance (KM)	0.0265	SE of Mean (KM)	0.0511
k hat (KM)	4.317	k star (KM)	3.498
nu hat (KM)	129.5	nu star (KM)	104.9
theta hat (KM)	0.0783	theta star (KM)	0.0967
80% gamma percentile (KM)	0.474	90% gamma percentile (KM)	0.581
95% gamma percentile (KM)	0.68	99% gamma percentile (KM)	0.893

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (104.95, α)	82.31	Adjusted Chi Square Value (104.95, β)	79.84
95% Gamma Approximate KM-UCL (use when n>=50)	0.431	95% Gamma Adjusted KM-UCL (use when n<50)	0.444

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.865	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.748	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.33	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.375	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.323	Mean in Log Scale	-1.2
SD in Original Scale	0.17	SD in Log Scale	0.336
95% t UCL (assumes normality of ROS data)	0.401	95% Percentile Bootstrap UCL	0.408
95% BCA Bootstrap UCL	0.445	95% Bootstrap t UCL	0.653
95% H-UCL (Log ROS)	0.378		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.151	KM Geo Mean	0.316
KM SD (logged)	0.32	95% Critical H Value (KM-Log)	1.898
KM Standard Error of Mean (logged)	0.109	95% H-UCL (KM -Log)	0.392
KM SD (logged)	0.32	95% Critical H Value (KM-Log)	1.898
KM Standard Error of Mean (logged)	0.109		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.284	Mean in Log Scale	-1.377
SD in Original Scale	0.189	SD in Log Scale	0.452
95% t UCL (Assumes normality)	0.37	95% H-Stat UCL	0.357

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.428

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	12
Number of Detects	8	Number of Non-Detects	7
Number of Distinct Detects	8	Number of Distinct Non-Detects	4

Minimum Detect	0.245	Minimum Non-Detect	0.235
Maximum Detect	1.94	Maximum Non-Detect	0.331
Variance Detects	0.333	Percent Non-Detects	46.67%
Mean Detects	0.546	SD Detects	0.577
Median Detects	0.334	CV Detects	1.057
Skewness Detects	2.594	Kurtosis Detects	6.891
Mean of Logged Detects	-0.888	SD of Logged Detects	0.693

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.577	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.387	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.402	KM Standard Error of Mean	0.117
KM SD	0.423	95% KM (BCA) UCL	0.621
95% KM (t) UCL	0.608	95% KM (Percentile Bootstrap) UCL	0.615
95% KM (z) UCL	0.594	95% KM Bootstrap t UCL	1.793
90% KM Chebyshev UCL	0.752	95% KM Chebyshev UCL	0.911
97.5% KM Chebyshev UCL	1.131	99% KM Chebyshev UCL	1.564

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.208	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.725	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.385	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.298	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.922	k star (bias corrected MLE)	1.284
Theta hat (MLE)	0.284	Theta star (bias corrected MLE)	0.425
nu hat (MLE)	30.75	nu star (bias corrected)	20.55
Mean (detects)	0.546		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.296
Maximum	1.94	Median	0.245
SD	0.493	CV	1.666
k hat (MLE)	0.458	k star (bias corrected MLE)	0.411
Theta hat (MLE)	0.645	Theta star (bias corrected MLE)	0.719
nu hat (MLE)	13.75	nu star (bias corrected)	12.34
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (12.34, α)	5.45	Adjusted Chi Square Value (12.34, β)	4.897
95% Gamma Approximate UCL (use when n>=50)	0.67	95% Gamma Adjusted UCL (use when n<50)	0.745

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.402	SD (KM)	0.423
Variance (KM)	0.179	SE of Mean (KM)	0.117
k hat (KM)	0.903	k star (KM)	0.767
nu hat (KM)	27.09	nu star (KM)	23.01
theta hat (KM)	0.445	theta star (KM)	0.524
80% gamma percentile (KM)	0.658	90% gamma percentile (KM)	0.987
95% gamma percentile (KM)	1.324	99% gamma percentile (KM)	2.121

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (23.01, α)	13.1	Adjusted Chi Square Value (23.01, β)	12.18
95% Gamma Approximate KM-UCL (use when n>=50)	0.706	95% Gamma Adjusted KM-UCL (use when n<50)	0.759

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.745	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.353	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.335	Mean in Log Scale	-1.608
SD in Original Scale	0.471	SD in Log Scale	0.967
95% t UCL (assumes normality of ROS data)	0.548	95% Percentile Bootstrap UCL	0.556
95% BCA Bootstrap UCL	0.688	95% Bootstrap t UCL	0.945
95% H-UCL (Log ROS)	0.641		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.145	KM Geo Mean	0.318
KM SD (logged)	0.549	95% Critical H Value (KM-Log)	2.121
KM Standard Error of Mean (logged)	0.152	95% H-UCL (KM -Log)	0.505
KM SD (logged)	0.549	95% Critical H Value (KM-Log)	2.121
KM Standard Error of Mean (logged)	0.152		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.35	Mean in Log Scale	-1.444
SD in Original Scale	0.462	SD in Log Scale	0.791
95% t UCL (Assumes normality)	0.56	95% H-Stat UCL	0.54

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.911

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	9
Number of Detects	9	Number of Non-Detects	6
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	0.07	Minimum Non-Detect	0.07
Maximum Detect	0.256	Maximum Non-Detect	0.07
Variance Detects	0.00568	Percent Non-Detects	40%
Mean Detects	0.123	SD Detects	0.0754
Median Detects	0.085	CV Detects	0.613
Skewness Detects	1.476	Kurtosis Detects	0.44
Mean of Logged Detects	-2.228	SD of Logged Detects	0.508

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.675	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.356	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.274	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.102	KM Standard Error of Mean	0.0167
KM SD	0.0608	95% KM (BCA) UCL	0.129
95% KM (t) UCL	0.131	95% KM (Percentile Bootstrap) UCL	0.133
95% KM (z) UCL	0.129	95% KM Bootstrap t UCL	0.214
90% KM Chebyshev UCL	0.152	95% KM Chebyshev UCL	0.174
97.5% KM Chebyshev UCL	0.206	99% KM Chebyshev UCL	0.268

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.265	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.725	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.36	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.28	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.966	k star (bias corrected MLE)	2.718
Theta hat (MLE)	0.031	Theta star (bias corrected MLE)	0.0452
nu hat (MLE)	71.39	nu star (bias corrected)	48.93
Mean (detects)	0.123		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0781
Maximum	0.256	Median	0.0743
SD	0.0805	CV	1.03
k hat (MLE)	0.965	k star (bias corrected MLE)	0.816
Theta hat (MLE)	0.0809	Theta star (bias corrected MLE)	0.0956
nu hat (MLE)	28.95	nu star (bias corrected)	24.49
Adjusted Level of Significance (β)	0.0324		
Approximate Chi Square Value (24.49, α)	14.22	Adjusted Chi Square Value (24.49, β)	13.27
95% Gamma Approximate UCL (use when n>=50)	0.134	95% Gamma Adjusted UCL (use when n<50)	0.144

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.102	SD (KM)	0.0608
Variance (KM)	0.0037	SE of Mean (KM)	0.0167
k hat (KM)	2.797	k star (KM)	2.282
nu hat (KM)	83.91	nu star (KM)	68.46
theta hat (KM)	0.0364	theta star (KM)	0.0446
80% gamma percentile (KM)	0.15	90% gamma percentile (KM)	0.192
95% gamma percentile (KM)	0.232	99% gamma percentile (KM)	0.319

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (68.46, α)	50.42	Adjusted Chi Square Value (68.46, β)	48.51
95% Gamma Approximate KM-UCL (use when n>=50)	0.138	95% Gamma Adjusted KM-UCL (use when n<50)	0.144

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.747	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.341	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0863	Mean in Log Scale	-2.744
SD in Original Scale	0.0738	SD in Log Scale	0.79
95% t UCL (assumes normality of ROS data)	0.12	95% Percentile Bootstrap UCL	0.119
95% BCA Bootstrap UCL	0.126	95% Bootstrap t UCL	0.156
95% H-UCL (Log ROS)	0.147		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.4	KM Geo Mean	0.0907
KM SD (logged)	0.427	95% Critical H Value (KM-Log)	1.994
KM Standard Error of Mean (logged)	0.117	95% H-UCL (KM -Log)	0.125
KM SD (logged)	0.427	95% Critical H Value (KM-Log)	1.994
KM Standard Error of Mean (logged)	0.117		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0877	Mean in Log Scale	-2.678
SD in Original Scale	0.0723	SD in Log Scale	0.688
95% t UCL (Assumes normality)	0.121	95% H-Stat UCL	0.133

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL 0.174

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	0.152	Mean	0.194
Maximum	0.349	Median	0.169
SD	0.0531	Std. Error of Mean	0.0137
Coefficient of Variation	0.273	Skewness	2.021

Normal GOF Test

Shapiro Wilk Test Statistic	0.76	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	0.218	95% Adjusted-CLT UCL (Chen-1995)	0.224
		95% Modified-t UCL (Johnson-1978)	0.219

Gamma GOF Test

A-D Test Statistic	1.014	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.735	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.226	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.221	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	17.88	k star (bias corrected MLE)	14.35
Theta hat (MLE)	0.0109	Theta star (bias corrected MLE)	0.0135
nu hat (MLE)	536.5	nu star (bias corrected)	430.5
MLE Mean (bias corrected)	0.194	MLE Sd (bias corrected)	0.0512
		Approximate Chi Square Value (0.05)	383.4
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	377.9

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.218	95% Adjusted Gamma UCL (use when n<50)	0.221

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.834	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.884	Mean of logged Data	-1.668
Maximum of Logged Data	-1.054	SD of logged Data	0.234

Assuming Lognormal Distribution

95% H-UCL	0.217	90% Chebyshev (MVUE) UCL	0.229
95% Chebyshev (MVUE) UCL	0.245	97.5% Chebyshev (MVUE) UCL	0.267
99% Chebyshev (MVUE) UCL	0.311		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.217	95% Jackknife UCL	0.218
95% Standard Bootstrap UCL	0.215	95% Bootstrap-t UCL	0.238
95% Hall's Bootstrap UCL	0.314	95% Percentile Bootstrap UCL	0.217
95% BCA Bootstrap UCL	0.226		
90% Chebyshev(Mean, Sd) UCL	0.235	95% Chebyshev(Mean, Sd) UCL	0.254
97.5% Chebyshev(Mean, Sd) UCL	0.28	99% Chebyshev(Mean, Sd) UCL	0.33

Suggested UCL to Use

95% Student's-t UCL	0.218	or 95% Modified-t UCL	0.219
or 95% H-UCL	0.217		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Zinc (mg/kg)

General Statistics

Total Number of Observations	15	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	13.66	Mean	40.89
Maximum	138	Median	26.8
SD	38.87	Std. Error of Mean	10.04
Coefficient of Variation	0.951	Skewness	2.163

Normal GOF Test

Shapiro Wilk Test Statistic	0.627	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.327	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.22	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	58.57	95% Adjusted-CLT UCL (Chen-1995)	63.39
		95% Modified-t UCL (Johnson-1978)	59.5

Appendix F5, Table 5. ProUCL Output - Whole Fish Tissue (Tar Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	1.41	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.243	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.224	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.023	k star (bias corrected MLE)	1.663
Theta hat (MLE)	20.21	Theta star (bias corrected MLE)	24.59
nu hat (MLE)	60.69	nu star (bias corrected)	49.88
MLE Mean (bias corrected)	40.89	MLE Sd (bias corrected)	31.71
		Approximate Chi Square Value (0.05)	34.67
Adjusted Level of Significance	0.0324	Adjusted Chi Square Value	33.11

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	58.84	95% Adjusted Gamma UCL (use when n<50)	61.61

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.849	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.881	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.184	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.22	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.614	Mean of logged Data	3.444
Maximum of Logged Data	4.927	SD of logged Data	0.677

Assuming Lognormal Distribution

95% H-UCL	59.43	90% Chebyshev (MVUE) UCL	59.98
95% Chebyshev (MVUE) UCL	69.63	97.5% Chebyshev (MVUE) UCL	83.03
99% Chebyshev (MVUE) UCL	109.3		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	57.4	95% Jackknife UCL	58.57
95% Standard Bootstrap UCL	56.39	95% Bootstrap-t UCL	106.2
95% Hall's Bootstrap UCL	153	95% Percentile Bootstrap UCL	57.64
95% BCA Bootstrap UCL	62.53		
90% Chebyshev(Mean, Sd) UCL	71	95% Chebyshev(Mean, Sd) UCL	84.64
97.5% Chebyshev(Mean, Sd) UCL	103.6	99% Chebyshev(Mean, Sd) UCL	140.7

Suggested UCL to Use

95% H-UCL	59.43

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Appendix F5, Table 6. ProUCL Output - Whole Fish Tissue (Neosho River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 3:17:29 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Barium (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	0.362	Mean	2.958
Maximum	8.205	Median	2.294
SD	2.357	Std. Error of Mean	0.556
Coefficient of Variation	0.797	Skewness	0.69

Normal GOF Test

Shapiro Wilk Test Statistic	0.913	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.141	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.925	95% Adjusted-CLT UCL (Chen-1995)	3.969
		95% Modified-t UCL (Johnson-1978)	3.94

Gamma GOF Test

A-D Test Statistic	0.397	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.759	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.158	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.208	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.368	k star (bias corrected MLE)	1.177
Theta hat (MLE)	2.163	Theta star (bias corrected MLE)	2.513
nu hat (MLE)	49.25	nu star (bias corrected)	42.37
MLE Mean (bias corrected)	2.958	MLE Sd (bias corrected)	2.727
		Approximate Chi Square Value (0.05)	28.45
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	27.36

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.406	95% Adjusted Gamma UCL (use when n<50)	4.582

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.92	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.017	Mean of logged Data	0.677
Maximum of Logged Data	2.105	SD of logged Data	1.027

Assuming Lognormal Distribution

95% H-UCL	6.497	90% Chebyshev (MVUE) UCL	5.786
95% Chebyshev (MVUE) UCL	6.959	97.5% Chebyshev (MVUE) UCL	8.586
99% Chebyshev (MVUE) UCL	11.78		

Appendix F5, Table 6. ProUCL Output - Whole Fish Tissue (Neosho River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.872	95% Jackknife UCL	3.925
95% Standard Bootstrap UCL	3.848	95% Bootstrap-t UCL	4.105
95% Hall's Bootstrap UCL	3.948	95% Percentile Bootstrap UCL	3.876
95% BCA Bootstrap UCL	3.858		
90% Chebyshev(Mean, Sd) UCL	4.625	95% Chebyshev(Mean, Sd) UCL	5.38
97.5% Chebyshev(Mean, Sd) UCL	6.427	99% Chebyshev(Mean, Sd) UCL	8.485

Suggested UCL to Use

95% Student's-t UCL 3.925

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	11
Number of Detects	11	Number of Non-Detects	7
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	0.03	Minimum Non-Detect	0.03
Maximum Detect	0.0722	Maximum Non-Detect	0.03
Variance Detects	1.8899E-4	Percent Non-Detects	38.89%
Mean Detects	0.0464	SD Detects	0.0137
Median Detects	0.0451	CV Detects	0.296
Skewness Detects	0.567	Kurtosis Detects	-0.598
Mean of Logged Detects	-3.11	SD of Logged Detects	0.293

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.94	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.145	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.04	KM Standard Error of Mean	0.00321
KM SD	0.013	95% KM (BCA) UCL	0.0448
95% KM (t) UCL	0.0456	95% KM (Percentile Bootstrap) UCL	0.0456
95% KM (z) UCL	0.0453	95% KM Bootstrap t UCL	0.0464
90% KM Chebyshev UCL	0.0496	95% KM Chebyshev UCL	0.054
97.5% KM Chebyshev UCL	0.0601	99% KM Chebyshev UCL	0.072

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.251	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.729	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.154	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.255	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	12.91	k star (bias corrected MLE)	9.452
Theta hat (MLE)	0.00359	Theta star (bias corrected MLE)	0.00491
nu hat (MLE)	284.1	nu star (bias corrected)	207.9
Mean (detects)	0.0464		

Appendix F5, Table 6. ProUCL Output - Whole Fish Tissue (Neosho River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0345
Maximum	0.0722	Median	0.0324
SD	0.0188	CV	0.546
k hat (MLE)	3.175	k star (bias corrected MLE)	2.683
Theta hat (MLE)	0.0109	Theta star (bias corrected MLE)	0.0129
nu hat (MLE)	114.3	nu star (bias corrected)	96.58
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (96.58, α)	74.92	Adjusted Chi Square Value (96.58, β)	73.08
95% Gamma Approximate UCL (use when n>=50)	0.0445	95% Gamma Adjusted UCL (use when n<50)	0.0456

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.04	SD (KM)	0.013
Variance (KM)	1.6873E-4	SE of Mean (KM)	0.00321
k hat (KM)	9.486	k star (KM)	7.942
nu hat (KM)	341.5	nu star (KM)	285.9
theta hat (KM)	0.00422	theta star (KM)	0.00504
80% gamma percentile (KM)	0.0512	90% gamma percentile (KM)	0.0589
95% gamma percentile (KM)	0.0659	99% gamma percentile (KM)	0.0802

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (285.92, α)	247.8	Adjusted Chi Square Value (285.92, β)	244.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.0462	95% Gamma Adjusted KM-UCL (use when n<50)	0.0468

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.14	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0364	Mean in Log Scale	-3.415
SD in Original Scale	0.0168	SD in Log Scale	0.473
95% t UCL (assumes normality of ROS data)	0.0433	95% Percentile Bootstrap UCL	0.0428
95% BCA Bootstrap UCL	0.0432	95% Bootstrap t UCL	0.0444
95% H-UCL (Log ROS)	0.0462		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.264	KM Geo Mean	0.0382
KM SD (logged)	0.292	95% Critical H Value (KM-Log)	1.847
KM Standard Error of Mean (logged)	0.0721	95% H-UCL (KM -Log)	0.0454
KM SD (logged)	0.292	95% Critical H Value (KM-Log)	1.847
KM Standard Error of Mean (logged)	0.0721		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0342	Mean in Log Scale	-3.534
SD in Original Scale	0.0189	SD in Log Scale	0.591
95% t UCL (Assumes normality)	0.0419	95% H-Stat UCL	0.0471

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0456

Appendix F5, Table 6. ProUCL Output - Whole Fish Tissue (Neosho River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
Number of Detects	13	Number of Non-Detects	5
Number of Distinct Detects	13	Number of Distinct Non-Detects	5
Minimum Detect	0.212	Minimum Non-Detect	0.224
Maximum Detect	1.035	Maximum Non-Detect	0.496
Variance Detects	0.0537	Percent Non-Detects	27.78%
Mean Detects	0.504	SD Detects	0.232
Median Detects	0.469	CV Detects	0.459
Skewness Detects	0.851	Kurtosis Detects	0.903
Mean of Logged Detects	-0.784	SD of Logged Detects	0.473

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.933	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.161	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.436	KM Standard Error of Mean	0.0556
KM SD	0.223	95% KM (BCA) UCL	0.53
95% KM (t) UCL	0.533	95% KM (Percentile Bootstrap) UCL	0.523
95% KM (z) UCL	0.528	95% KM Bootstrap t UCL	0.546
90% KM Chebyshev UCL	0.603	95% KM Chebyshev UCL	0.679
97.5% KM Chebyshev UCL	0.784	99% KM Chebyshev UCL	0.99

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.229	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.736	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.109	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.197	k star (bias corrected MLE)	4.049
Theta hat (MLE)	0.097	Theta star (bias corrected MLE)	0.125
nu hat (MLE)	135.1	nu star (bias corrected)	105.3
Mean (detects)	0.504		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.185	Mean	0.431
Maximum	1.035	Median	0.388
SD	0.231	CV	0.534
k hat (MLE)	4.144	k star (bias corrected MLE)	3.491
Theta hat (MLE)	0.104	Theta star (bias corrected MLE)	0.124
nu hat (MLE)	149.2	nu star (bias corrected)	125.7
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (125.66, α)	100.8	Adjusted Chi Square Value (125.66, β)	98.63
95% Gamma Approximate UCL (use when n>=50)	0.538	95% Gamma Adjusted UCL (use when n<50)	0.55

Appendix F5, Table 6. ProUCL Output - Whole Fish Tissue (Neosho River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.436	SD (KM)	0.223
Variance (KM)	0.0496	SE of Mean (KM)	0.0556
k hat (KM)	3.843	k star (KM)	3.24
nu hat (KM)	138.4	nu star (KM)	116.6
theta hat (KM)	0.114	theta star (KM)	0.135
80% gamma percentile (KM)	0.617	90% gamma percentile (KM)	0.762
95% gamma percentile (KM)	0.896	99% gamma percentile (KM)	1.187

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (116.64, α)	92.7	Adjusted Chi Square Value (116.64, β)	90.65
95% Gamma Approximate KM-UCL (use when n>=50)	0.549	95% Gamma Adjusted KM-UCL (use when n<50)	0.562

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.958	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.12	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.234	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.437	Mean in Log Scale	-0.942
SD in Original Scale	0.225	SD in Log Scale	0.482
95% t UCL (assumes normality of ROS data)	0.529	95% Percentile Bootstrap UCL	0.524
95% BCA Bootstrap UCL	0.543	95% Bootstrap t UCL	0.552
95% H-UCL (Log ROS)	0.554		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.951	KM Geo Mean	0.386
KM SD (logged)	0.492	95% Critical H Value (KM-Log)	2.013
KM Standard Error of Mean (logged)	0.125	95% H-UCL (KM -Log)	0.554
KM SD (logged)	0.492	95% Critical H Value (KM-Log)	2.013
KM Standard Error of Mean (logged)	0.125		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.415	Mean in Log Scale	-1.054
SD in Original Scale	0.247	SD in Log Scale	0.627
95% t UCL (Assumes normality)	0.516	95% H-Stat UCL	0.589

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.533

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	16
Number of Detects	15	Number of Non-Detects	3
Number of Distinct Detects	15	Number of Distinct Non-Detects	2
Minimum Detect	0.24	Minimum Non-Detect	0.237
Maximum Detect	2.036	Maximum Non-Detect	0.24
Variance Detects	0.242	Percent Non-Detects	16.67%
Mean Detects	0.514	SD Detects	0.492
Median Detects	0.314	CV Detects	0.956
Skewness Detects	2.681	Kurtosis Detects	7.019
Mean of Logged Detects	-0.898	SD of Logged Detects	0.603

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.558	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.367	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.468	KM Standard Error of Mean	0.109
KM SD	0.446	95% KM (BCA) UCL	0.69
95% KM (t) UCL	0.657	95% KM (Percentile Bootstrap) UCL	0.651
95% KM (z) UCL	0.647	95% KM Bootstrap t UCL	1.32
90% KM Chebyshev UCL	0.794	95% KM Chebyshev UCL	0.942
97.5% KM Chebyshev UCL	1.147	99% KM Chebyshev UCL	1.55

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.167	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.746	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.285	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.224	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.308	k star (bias corrected MLE)	1.891
Theta hat (MLE)	0.223	Theta star (bias corrected MLE)	0.272
nu hat (MLE)	69.24	nu star (bias corrected)	56.73
Mean (detects)	0.514		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.43
Maximum	2.036	Median	0.299
SD	0.486	CV	1.131
k hat (MLE)	0.874	k star (bias corrected MLE)	0.765
Theta hat (MLE)	0.492	Theta star (bias corrected MLE)	0.562
nu hat (MLE)	31.46	nu star (bias corrected)	27.55
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (27.55, α)	16.58	Adjusted Chi Square Value (27.55, β)	15.76
95% Gamma Approximate UCL (use when n>=50)	0.714	95% Gamma Adjusted UCL (use when n<50)	0.751

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.468	SD (KM)	0.446
Variance (KM)	0.199	SE of Mean (KM)	0.109
k hat (KM)	1.101	k star (KM)	0.955
nu hat (KM)	39.65	nu star (KM)	34.37
theta hat (KM)	0.425	theta star (KM)	0.49
80% gamma percentile (KM)	0.755	90% gamma percentile (KM)	1.089
95% gamma percentile (KM)	1.424	99% gamma percentile (KM)	2.205

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (34.37, α)	21.96	Adjusted Chi Square Value (34.37, β)	21.01
95% Gamma Approximate KM-UCL (use when n>=50)	0.732	95% Gamma Adjusted KM-UCL (use when n<50)	0.765

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.728	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.881	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.262	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.22	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.448	Mean in Log Scale	-1.108
SD in Original Scale	0.471	SD in Log Scale	0.732
95% t UCL (assumes normality of ROS data)	0.641	95% Percentile Bootstrap UCL	0.647
95% BCA Bootstrap UCL	0.718	95% Bootstrap t UCL	1.124
95% H-UCL (Log ROS)	0.647		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.988	KM Geo Mean	0.372
KM SD (logged)	0.569	95% Critical H Value (KM-Log)	2.091
KM Standard Error of Mean (logged)	0.139	95% H-UCL (KM -Log)	0.584
KM SD (logged)	0.569	95% Critical H Value (KM-Log)	2.091
KM Standard Error of Mean (logged)	0.139		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.448	Mean in Log Scale	-1.102
SD in Original Scale	0.471	SD in Log Scale	0.722
95% t UCL (Assumes normality)	0.641	95% H-Stat UCL	0.641

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	0.942

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	11
Number of Detects	10	Number of Non-Detects	8
Number of Distinct Detects	10	Number of Distinct Non-Detects	1
Minimum Detect	0.0725	Minimum Non-Detect	0.07
Maximum Detect	0.0984	Maximum Non-Detect	0.07
Variance Detects	7.8506E-5	Percent Non-Detects	44.44%
Mean Detects	0.0823	SD Detects	0.00886
Median Detects	0.0809	CV Detects	0.108
Skewness Detects	0.559	Kurtosis Detects	-0.865
Mean of Logged Detects	-2.503	SD of Logged Detects	0.106

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.226	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0768	KM Standard Error of Mean	0.00217
KM SD	0.00875	95% KM (BCA) UCL	0.0802
95% KM (t) UCL	0.0806	95% KM (Percentile Bootstrap) UCL	0.0803
95% KM (z) UCL	0.0804	95% KM Bootstrap t UCL	0.0812
90% KM Chebyshev UCL	0.0833	95% KM Chebyshev UCL	0.0863
97.5% KM Chebyshev UCL	0.0904	99% KM Chebyshev UCL	0.0985

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.475	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.233	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.266	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	98.23	k star (bias corrected MLE)	68.83
Theta hat (MLE)	8.3775E-4	Theta star (bias corrected MLE)	0.0012
nu hat (MLE)	1965	nu star (bias corrected)	1377
Mean (detects)	0.0823		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0473	Mean	0.0719
Maximum	0.0984	Median	0.0729
SD	0.0143	CV	0.198
k hat (MLE)	26.33	k star (bias corrected MLE)	21.98
Theta hat (MLE)	0.00273	Theta star (bias corrected MLE)	0.00327
nu hat (MLE)	947.8	nu star (bias corrected)	791.2
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (791.19, α)	726.9	Adjusted Chi Square Value (791.19, β)	721
95% Gamma Approximate UCL (use when n>=50)	0.0783	95% Gamma Adjusted UCL (use when n<50)	0.0789

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0768	SD (KM)	0.00875
Variance (KM)	7.6548E-5	SE of Mean (KM)	0.00217
k hat (KM)	77.11	k star (KM)	64.29
nu hat (KM)	2776	nu star (KM)	2315
theta hat (KM)	9.9636E-4	theta star (KM)	0.00119
80% gamma percentile (KM)	0.0848	90% gamma percentile (KM)	0.0893
95% gamma percentile (KM)	0.0932	99% gamma percentile (KM)	0.101

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (N/A, α)	2204	Adjusted Chi Square Value (N/A, β)	2193
95% Gamma Approximate KM-UCL (use when n>=50)	0.0807	95% Gamma Adjusted KM-UCL (use when n<50)	0.0811

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.91	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.221	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0729	Mean in Log Scale	-2.634
SD in Original Scale	0.0131	SD in Log Scale	0.179
95% t UCL (assumes normality of ROS data)	0.0783	95% Percentile Bootstrap UCL	0.0778
95% BCA Bootstrap UCL	0.0783	95% Bootstrap t UCL	0.0789
95% H-UCL (Log ROS)	0.0788		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.572	KM Geo Mean	0.0764
KM SD (logged)	0.108	95% Critical H Value (KM-Log)	1.737
KM Standard Error of Mean (logged)	0.0268	95% H-UCL (KM -Log)	0.0804
KM SD (logged)	0.108	95% Critical H Value (KM-Log)	1.737
KM Standard Error of Mean (logged)	0.0268		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.0613	Mean in Log Scale	-2.88
SD in Original Scale	0.025	SD in Log Scale	0.441
95% t UCL (Assumes normality)	0.0715	95% H-Stat UCL	0.0763

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 0.0806

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	17
Number of Detects	16	Number of Non-Detects	2
Number of Distinct Detects	16	Number of Distinct Non-Detects	1
Minimum Detect	0.155	Minimum Non-Detect	0.15
Maximum Detect	0.348	Maximum Non-Detect	0.15
Variance Detects	0.00348	Percent Non-Detects	11.11%
Mean Detects	0.22	SD Detects	0.059
Median Detects	0.201	CV Detects	0.269
Skewness Detects	0.978	Kurtosis Detects	-0.0518
Mean of Logged Detects	-1.546	SD of Logged Detects	0.252

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.877	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.177	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.212	KM Standard Error of Mean	0.0142
KM SD	0.0582	95% KM (BCA) UCL	0.236
95% KM (t) UCL	0.237	95% KM (Percentile Bootstrap) UCL	0.236
95% KM (z) UCL	0.235	95% KM Bootstrap t UCL	0.244
90% KM Chebyshev UCL	0.254	95% KM Chebyshev UCL	0.274
97.5% KM Chebyshev UCL	0.3	99% KM Chebyshev UCL	0.353

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.626	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.737	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.158	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.215	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	16.33	k star (bias corrected MLE)	13.31
Theta hat (MLE)	0.0135	Theta star (bias corrected MLE)	0.0165
nu hat (MLE)	522.7	nu star (bias corrected)	426
Mean (detects)	0.22		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0909	Mean	0.206
Maximum	0.348	Median	0.198
SD	0.0677	CV	0.328
k hat (MLE)	9.613	k star (bias corrected MLE)	8.048
Theta hat (MLE)	0.0215	Theta star (bias corrected MLE)	0.0257
nu hat (MLE)	346.1	nu star (bias corrected)	289.7
Adjusted Level of Significance (β)	0.0357		
Approximate Chi Square Value (289.72, α)	251.3	Adjusted Chi Square Value (289.72, β)	247.9
95% Gamma Approximate UCL (use when n>=50)	0.238	95% Gamma Adjusted UCL (use when n<50)	0.241

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.212	SD (KM)	0.0582
Variance (KM)	0.00338	SE of Mean (KM)	0.0142
k hat (KM)	13.29	k star (KM)	11.11
nu hat (KM)	478.4	nu star (KM)	400
theta hat (KM)	0.016	theta star (KM)	0.0191
80% gamma percentile (KM)	0.263	90% gamma percentile (KM)	0.296
95% gamma percentile (KM)	0.326	99% gamma percentile (KM)	0.387

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (399.99, α)	354.6	Adjusted Chi Square Value (399.99, β)	350.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.239	95% Gamma Adjusted KM-UCL (use when n<50)	0.242

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.144	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.208	Mean in Log Scale	-1.612
SD in Original Scale	0.0645	SD in Log Scale	0.305
95% t UCL (assumes normality of ROS data)	0.235	95% Percentile Bootstrap UCL	0.234
95% BCA Bootstrap UCL	0.234	95% Bootstrap t UCL	0.237
95% H-UCL (Log ROS)	0.24		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.585	KM Geo Mean	0.205
KM SD (logged)	0.255	95% Critical H Value (KM-Log)	1.822
KM Standard Error of Mean (logged)	0.062	95% H-UCL (KM -Log)	0.237
KM SD (logged)	0.255	95% Critical H Value (KM-Log)	1.822
KM Standard Error of Mean (logged)	0.062		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.204	Mean in Log Scale	-1.662
SD in Original Scale	0.0725	SD in Log Scale	0.412
95% t UCL (Assumes normality)	0.233	95% H-Stat UCL	0.251

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.237

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix F5, Table 6. ProUCL Output - Whole Fish Tissue (Neosho River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	18	Number of Distinct Observations	18
		Number of Missing Observations	0
Minimum	9.991	Mean	19.34
Maximum	46.77	Median	16.69
SD	9.313	Std. Error of Mean	2.195
Coefficient of Variation	0.482	Skewness	2.153

Normal GOF Test

Shapiro Wilk Test Statistic	0.732	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.271	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	23.15	95% Adjusted-CLT UCL (Chen-1995)	24.14
		95% Modified-t UCL (Johnson-1978)	23.34

Gamma GOF Test

A-D Test Statistic	1.073	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.204	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.445	k star (bias corrected MLE)	5.408
Theta hat (MLE)	3	Theta star (bias corrected MLE)	3.575
nu hat (MLE)	232	nu star (bias corrected)	194.7
MLE Mean (bias corrected)	19.34	MLE Sd (bias corrected)	8.314
		Approximate Chi Square Value (0.05)	163.4
Adjusted Level of Significance	0.0357	Adjusted Chi Square Value	160.7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	23.04	95% Adjusted Gamma UCL (use when n<50)	23.43

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.897	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.202	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.302	Mean of logged Data	2.882
Maximum of Logged Data	3.845	SD of logged Data	0.383

Assuming Lognormal Distribution

95% H-UCL	22.96	90% Chebyshev (MVUE) UCL	24.42
95% Chebyshev (MVUE) UCL	26.81	97.5% Chebyshev (MVUE) UCL	30.14
99% Chebyshev (MVUE) UCL	36.67		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix F5, Table 6. ProUCL Output - Whole Fish Tissue (Neosho River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	22.95	95% Jackknife UCL	23.15
95% Standard Bootstrap UCL	22.84	95% Bootstrap-t UCL	28.14
95% Hall's Bootstrap UCL	44.29	95% Percentile Bootstrap UCL	23.17
95% BCA Bootstrap UCL	24.01		
90% Chebyshev(Mean, Sd) UCL	25.92	95% Chebyshev(Mean, Sd) UCL	28.9
97.5% Chebyshev(Mean, Sd) UCL	33.04	99% Chebyshev(Mean, Sd) UCL	41.18

Suggested UCL to Use

95% Student's-t UCL	23.15	or 95% Modified-t UCL	23.34
or 95% H-UCL	22.96		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 3:15:48 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Barium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.439	Mean	2.695
Maximum	6.613	Median	2.286
SD	1.692	Std. Error of Mean	0.452
Coefficient of Variation	0.628	Skewness	0.923

Normal GOF Test

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.496	95% Adjusted-CLT UCL (Chen-1995)	3.558
		95% Modified-t UCL (Johnson-1978)	3.514

Gamma GOF Test

A-D Test Statistic	0.125	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.102	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.231	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.557	k star (bias corrected MLE)	2.056
Theta hat (MLE)	1.054	Theta star (bias corrected MLE)	1.31
nu hat (MLE)	71.59	nu star (bias corrected)	57.58
MLE Mean (bias corrected)	2.695	MLE Sd (bias corrected)	1.879
		Approximate Chi Square Value (0.05)	41.14
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	39.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.772	95% Adjusted Gamma UCL (use when n<50)	3.949

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.145	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.824	Mean of logged Data	0.783
Maximum of Logged Data	1.889	SD of logged Data	0.718

Assuming Lognormal Distribution

95% H-UCL	4.531	90% Chebyshev (MVUE) UCL	4.448
95% Chebyshev (MVUE) UCL	5.208	97.5% Chebyshev (MVUE) UCL	6.263
99% Chebyshev (MVUE) UCL	8.335		

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.439	95% Jackknife UCL	3.496
95% Standard Bootstrap UCL	3.415	95% Bootstrap-t UCL	3.681
95% Hall's Bootstrap UCL	3.727	95% Percentile Bootstrap UCL	3.441
95% BCA Bootstrap UCL	3.592		
90% Chebyshev(Mean, Sd) UCL	4.051	95% Chebyshev(Mean, Sd) UCL	4.666
97.5% Chebyshev(Mean, Sd) UCL	5.519	99% Chebyshev(Mean, Sd) UCL	7.194

Suggested UCL to Use

95% Student's-t UCL	3.496

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	12
Number of Detects	11	Number of Non-Detects	3
Number of Distinct Detects	11	Number of Distinct Non-Detects	1
Minimum Detect	0.0378	Minimum Non-Detect	0.03
Maximum Detect	0.168	Maximum Non-Detect	0.03
Variance Detects	0.00134	Percent Non-Detects	21.43%
Mean Detects	0.0629	SD Detects	0.0366
Median Detects	0.0475	CV Detects	0.582
Skewness Detects	2.791	Kurtosis Detects	8.404
Mean of Logged Detects	-2.863	SD of Logged Detects	0.412

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.621	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.295	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.251	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0558	KM Standard Error of Mean	0.00945
KM SD	0.0337	95% KM (BCA) UCL	0.0741
95% KM (t) UCL	0.0726	95% KM (Percentile Bootstrap) UCL	0.0732
95% KM (z) UCL	0.0714	95% KM Bootstrap t UCL	0.0914
90% KM Chebyshev UCL	0.0842	95% KM Chebyshev UCL	0.097
97.5% KM Chebyshev UCL	0.115	99% KM Chebyshev UCL	0.15

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.112	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.731	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.227	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.256	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	5.347	k star (bias corrected MLE)	3.95
Theta hat (MLE)	0.0118	Theta star (bias corrected MLE)	0.0159
nu hat (MLE)	117.6	nu star (bias corrected)	86.89
Mean (detects)	0.0629		

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0516
Maximum	0.168	Median	0.0462
SD	0.0391	CV	0.758
k hat (MLE)	2.023	k star (bias corrected MLE)	1.637
Theta hat (MLE)	0.0255	Theta star (bias corrected MLE)	0.0315
nu hat (MLE)	56.66	nu star (bias corrected)	45.85
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (45.85, α)	31.31	Adjusted Chi Square Value (45.85, β)	29.73
95% Gamma Approximate UCL (use when n>=50)	0.0756	95% Gamma Adjusted UCL (use when n<50)	0.0796

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0558	SD (KM)	0.0337
Variance (KM)	0.00114	SE of Mean (KM)	0.00945
k hat (KM)	2.742	k star (KM)	2.202
nu hat (KM)	76.77	nu star (KM)	61.65
theta hat (KM)	0.0204	theta star (KM)	0.0254
80% gamma percentile (KM)	0.0826	90% gamma percentile (KM)	0.106
95% gamma percentile (KM)	0.129	99% gamma percentile (KM)	0.178

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (61.65, α)	44.59	Adjusted Chi Square Value (61.65, β)	42.67
95% Gamma Approximate KM-UCL (use when n>=50)	0.0772	95% Gamma Adjusted KM-UCL (use when n<50)	0.0807

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.795	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.85	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.217	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.251	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0543	Mean in Log Scale	-3.061
SD in Original Scale	0.0363	SD in Log Scale	0.539
95% t UCL (assumes normality of ROS data)	0.0715	95% Percentile Bootstrap UCL	0.0708
95% BCA Bootstrap UCL	0.0784	95% Bootstrap t UCL	0.0861
95% H-UCL (Log ROS)	0.0737		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-3.001	KM Geo Mean	0.0497
KM SD (logged)	0.437	95% Critical H Value (KM-Log)	2.001
KM Standard Error of Mean (logged)	0.123	95% H-UCL (KM -Log)	0.0698
KM SD (logged)	0.437	95% Critical H Value (KM-Log)	2.001
KM Standard Error of Mean (logged)	0.123		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0526	Mean in Log Scale	-3.149
SD in Original Scale	0.038	SD in Log Scale	0.674
95% t UCL (Assumes normality)	0.0706	95% H-Stat UCL	0.0829

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.0807	95% GROS Adjusted Gamma UCL	0.0796

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.369	Mean	0.582
Maximum	0.906	Median	0.569
SD	0.154	Std. Error of Mean	0.0413
Coefficient of Variation	0.265	Skewness	0.671

Normal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.655	95% Adjusted-CLT UCL (Chen-1995)	0.658
		95% Modified-t UCL (Johnson-1978)	0.657

Gamma GOF Test

A-D Test Statistic	0.163	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.103	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.228	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	15.95	k star (bias corrected MLE)	12.58
Theta hat (MLE)	0.0365	Theta star (bias corrected MLE)	0.0463
nu hat (MLE)	446.5	nu star (bias corrected)	352.2
MLE Mean (bias corrected)	0.582	MLE Sd (bias corrected)	0.164
		Approximate Chi Square Value (0.05)	309.7
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	304.4

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.662	95% Adjusted Gamma UCL (use when n<50)	0.674

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.983	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0891	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.998	Mean of logged Data	-0.573
Maximum of Logged Data	-0.0993	SD of logged Data	0.26

Assuming Lognormal Distribution

95% H-UCL	0.667	90% Chebyshev (MVUE) UCL	0.705
95% Chebyshev (MVUE) UCL	0.76	97.5% Chebyshev (MVUE) UCL	0.837
99% Chebyshev (MVUE) UCL	0.988		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nonparametric Distribution Free UCLs

95% CLT UCL	0.65	95% Jackknife UCL	0.655
95% Standard Bootstrap UCL	0.645	95% Bootstrap-t UCL	0.664
95% Hall's Bootstrap UCL	0.671	95% Percentile Bootstrap UCL	0.652
95% BCA Bootstrap UCL	0.651		
90% Chebyshev(Mean, Sd) UCL	0.706	95% Chebyshev(Mean, Sd) UCL	0.762
97.5% Chebyshev(Mean, Sd) UCL	0.84	99% Chebyshev(Mean, Sd) UCL	0.993

Suggested UCL to Use

95% Student's-t UCL 0.655

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	11
Number of Detects	7	Number of Non-Detects	7
Number of Distinct Detects	7	Number of Distinct Non-Detects	4
Minimum Detect	0.273	Minimum Non-Detect	0.232
Maximum Detect	2.859	Maximum Non-Detect	0.252
Variance Detects	0.827	Percent Non-Detects	50%
Mean Detects	0.86	SD Detects	0.909
Median Detects	0.482	CV Detects	1.058
Skewness Detects	2.325	Kurtosis Detects	5.68
Mean of Logged Detects	-0.479	SD of Logged Detects	0.802

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.671	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.803	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.366	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.304	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.546	KM Standard Error of Mean	0.194
KM SD	0.673	95% KM (BCA) UCL	0.877
95% KM (t) UCL	0.89	95% KM (Percentile Bootstrap) UCL	0.873
95% KM (z) UCL	0.865	95% KM Bootstrap t UCL	1.507
90% KM Chebyshev UCL	1.129	95% KM Chebyshev UCL	1.393
97.5% KM Chebyshev UCL	1.759	99% KM Chebyshev UCL	2.479

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.601	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.719	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.266	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.316	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.671	k star (bias corrected MLE)	1.05
Theta hat (MLE)	0.514	Theta star (bias corrected MLE)	0.819
nu hat (MLE)	23.4	nu star (bias corrected)	14.7
Mean (detects)	0.86		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Minimum	0.01	Mean	0.435
Maximum	2.859	Median	0.141
SD	0.759	CV	1.745
k hat (MLE)	0.387	k star (bias corrected MLE)	0.352
Theta hat (MLE)	1.124	Theta star (bias corrected MLE)	1.236
nu hat (MLE)	10.84	nu star (bias corrected)	9.847
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (9.85, α)	3.847	Adjusted Chi Square Value (9.85, β)	3.364
95% Gamma Approximate UCL (use when n>=50)	1.113	95% Gamma Adjusted UCL (use when n<50)	1.273

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.546	SD (KM)	0.673
Variance (KM)	0.453	SE of Mean (KM)	0.194
k hat (KM)	0.657	k star (KM)	0.564
nu hat (KM)	18.4	nu star (KM)	15.79
theta hat (KM)	0.83	theta star (KM)	0.967
80% gamma percentile (KM)	0.899	90% gamma percentile (KM)	1.439
95% gamma percentile (KM)	2.008	99% gamma percentile (KM)	3.391

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (15.79, α)	7.817	Adjusted Chi Square Value (15.79, β)	7.084
95% Gamma Approximate KM-UCL (use when n>=50)	1.103	95% Gamma Adjusted KM-UCL (use when n<50)	1.217

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.803	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.304	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.463	Mean in Log Scale	-1.641
SD in Original Scale	0.743	SD in Log Scale	1.367
95% t UCL (assumes normality of ROS data)	0.815	95% Percentile Bootstrap UCL	0.822
95% BCA Bootstrap UCL	0.967	95% Bootstrap t UCL	1.416
95% H-UCL (Log ROS)	1.816		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.971	KM Geo Mean	0.379
KM SD (logged)	0.719	95% Critical H Value (KM-Log)	2.362
KM Standard Error of Mean (logged)	0.208	95% H-UCL (KM -Log)	0.786
KM SD (logged)	0.719	95% Critical H Value (KM-Log)	2.362
KM Standard Error of Mean (logged)	0.208		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.49	Mean in Log Scale	-1.301
SD in Original Scale	0.727	SD in Log Scale	1.012
95% t UCL (Assumes normality)	0.834	95% H-Stat UCL	1.001

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	1.217	95% GROS Adjusted Gamma UCL	1.273

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Nickel (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	10
Number of Detects	9	Number of Non-Detects	5
Number of Distinct Detects	9	Number of Distinct Non-Detects	1
Minimum Detect	0.0727	Minimum Non-Detect	0.07
Maximum Detect	0.109	Maximum Non-Detect	0.07
Variance Detects	1.9689E-4	Percent Non-Detects	35.71%
Mean Detects	0.0874	SD Detects	0.014
Median Detects	0.0828	CV Detects	0.16
Skewness Detects	0.655	Kurtosis Detects	-1.136
Mean of Logged Detects	-2.448	SD of Logged Detects	0.156

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.877	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.274	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0812	KM Standard Error of Mean	0.00383
KM SD	0.0135	95% KM (BCA) UCL	0.0875
95% KM (t) UCL	0.088	95% KM (Percentile Bootstrap) UCL	0.0874
95% KM (z) UCL	0.0875	95% KM Bootstrap t UCL	0.0898
90% KM Chebyshev UCL	0.0927	95% KM Chebyshev UCL	0.0979
97.5% KM Chebyshev UCL	0.105	99% KM Chebyshev UCL	0.119

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.445	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.721	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.179	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.279	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	45.47	k star (bias corrected MLE)	30.38
Theta hat (MLE)	0.00192	Theta star (bias corrected MLE)	0.00288
nu hat (MLE)	818.4	nu star (bias corrected)	546.9
Mean (detects)	0.0874		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0417	Mean	0.0753
Maximum	0.109	Median	0.0749
SD	0.0207	CV	0.275
k hat (MLE)	13.68	k star (bias corrected MLE)	10.79
Theta hat (MLE)	0.00551	Theta star (bias corrected MLE)	0.00698
nu hat (MLE)	382.9	nu star (bias corrected)	302.2
Adjusted Level of Significance (β)	0.0312		
Approximate Chi Square Value (302.19, α)	262.9	Adjusted Chi Square Value (302.19, β)	258.1
95% Gamma Approximate UCL (use when n>=50)	0.0865	95% Gamma Adjusted UCL (use when n<50)	0.0882

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0812	SD (KM)	0.0135
Variance (KM)	1.8226E-4	SE of Mean (KM)	0.00383
k hat (KM)	36.18	k star (KM)	28.48
nu hat (KM)	1013	nu star (KM)	797.3
theta hat (KM)	0.00224	theta star (KM)	0.00285
80% gamma percentile (KM)	0.0937	90% gamma percentile (KM)	0.101
95% gamma percentile (KM)	0.108	99% gamma percentile (KM)	0.121

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (797.31, α)	732.8	Adjusted Chi Square Value (797.31, β)	724.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.0884	95% Gamma Adjusted KM-UCL (use when n<50)	0.0894

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.894	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.829	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.274	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0768	Mean in Log Scale	-2.595
SD in Original Scale	0.0188	SD in Log Scale	0.246
95% t UCL (assumes normality of ROS data)	0.0857	95% Percentile Bootstrap UCL	0.0847
95% BCA Bootstrap UCL	0.0855	95% Bootstrap t UCL	0.0866
95% H-UCL (Log ROS)	0.0873		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.523	KM Geo Mean	0.0802
KM SD (logged)	0.156	95% Critical H Value (KM-Log)	1.789
KM Standard Error of Mean (logged)	0.0441	95% H-UCL (KM -Log)	0.0877
KM SD (logged)	0.156	95% Critical H Value (KM-Log)	1.789
KM Standard Error of Mean (logged)	0.0441		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0687	Mean in Log Scale	-2.771
SD in Original Scale	0.0283	SD in Log Scale	0.466
95% t UCL (Assumes normality)	0.0821	95% H-Stat UCL	0.0905

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.088

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	0.174	Mean	0.401
Maximum	0.587	Median	0.44
SD	0.145	Std. Error of Mean	0.0387
Coefficient of Variation	0.361	Skewness	-0.548

Normal GOF Test

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.19	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.47	95% Adjusted-CLT UCL (Chen-1995)	0.459
		95% Modified-t UCL (Johnson-1978)	0.469

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Gamma GOF Test

A-D Test Statistic	1.041	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.737	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.209	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.229	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.677	k star (bias corrected MLE)	5.294
Theta hat (MLE)	0.0601	Theta star (bias corrected MLE)	0.0758
nu hat (MLE)	186.9	nu star (bias corrected)	148.2
MLE Mean (bias corrected)	0.401	MLE Sd (bias corrected)	0.174
		Approximate Chi Square Value (0.05)	121.1
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	117.8

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.491	95% Adjusted Gamma UCL (use when n<50)	0.505

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.823	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.219	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.75	Mean of logged Data	-0.99
Maximum of Logged Data	-0.534	SD of logged Data	0.431

Assuming Lognormal Distribution

95% H-UCL	0.518	90% Chebyshev (MVUE) UCL	0.548
95% Chebyshev (MVUE) UCL	0.613	97.5% Chebyshev (MVUE) UCL	0.703
99% Chebyshev (MVUE) UCL	0.879		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.465	95% Jackknife UCL	0.47
95% Standard Bootstrap UCL	0.461	95% Bootstrap-t UCL	0.464
95% Hall's Bootstrap UCL	0.458	95% Percentile Bootstrap UCL	0.46
95% BCA Bootstrap UCL	0.454		
90% Chebyshev(Mean, Sd) UCL	0.517	95% Chebyshev(Mean, Sd) UCL	0.57
97.5% Chebyshev(Mean, Sd) UCL	0.643	99% Chebyshev(Mean, Sd) UCL	0.786

Suggested UCL to Use

95% Student's-t UCL	0.47

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Zinc (mg/kg)

General Statistics

Total Number of Observations	14	Number of Distinct Observations	14
		Number of Missing Observations	0
Minimum	12.25	Mean	24.03
Maximum	77.61	Median	18.19
SD	17.16	Std. Error of Mean	4.587
Coefficient of Variation	0.714	Skewness	2.735

Normal GOF Test

Shapiro Wilk Test Statistic	0.634	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.343	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.226	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	32.15	95% Adjusted-CLT UCL (Chen-1995)	35.16
		95% Modified-t UCL (Johnson-1978)	32.71

Gamma GOF Test

A-D Test Statistic	1.185	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.741	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.269	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.23	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.656	k star (bias corrected MLE)	2.92
Theta hat (MLE)	6.572	Theta star (bias corrected MLE)	8.228
nu hat (MLE)	102.4	nu star (bias corrected)	81.77
MLE Mean (bias corrected)	24.03	MLE Sd (bias corrected)	14.06
		Approximate Chi Square Value (0.05)	61.93
Adjusted Level of Significance	0.0312	Adjusted Chi Square Value	59.64

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	31.73	95% Adjusted Gamma UCL (use when n<50)	32.94

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.841	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.874	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.224	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.226	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.506	Mean of logged Data	3.036
Maximum of Logged Data	4.352	SD of logged Data	0.494

Assuming Lognormal Distribution

95% H-UCL	30.99	90% Chebyshev (MVUE) UCL	32.8
95% Chebyshev (MVUE) UCL	37.1	97.5% Chebyshev (MVUE) UCL	43.07
99% Chebyshev (MVUE) UCL	54.79		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	31.58	95% Jackknife UCL	32.15
95% Standard Bootstrap UCL	31.15	95% Bootstrap-t UCL	49.97
95% Hall's Bootstrap UCL	68.26	95% Percentile Bootstrap UCL	32.3
95% BCA Bootstrap UCL	35.4		
90% Chebyshev(Mean, Sd) UCL	37.79	95% Chebyshev(Mean, Sd) UCL	44.03
97.5% Chebyshev(Mean, Sd) UCL	52.68	99% Chebyshev(Mean, Sd) UCL	69.67

Appendix F5, Table 7. ProUCL Output - Whole Fish Tissue (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Suggested UCL to Use

95% Student's-t UCL	32.15	or 95% Modified-t UCL	32.71
or 95% H-UCL	30.99		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Appendix F5, Table 8. ProUCL Output - Shellfish (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 4:33:05 PM
From File	TCOU5 ProUCL Tables 190506.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Barium (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	9
Number of Detects	8	Number of Non-Detects	1
Number of Distinct Detects	8	Number of Distinct Non-Detects	1
Minimum Detect	5.24	Minimum Non-Detect	4.01
Maximum Detect	101	Maximum Non-Detect	4.01
Variance Detects	1633	Percent Non-Detects	11.11%
Mean Detects	49.79	SD Detects	40.4
Median Detects	53.3	CV Detects	0.812
Skewness Detects	0.0101	Kurtosis Detects	-2.348
Mean of Logged Detects	3.398	SD of Logged Detects	1.24

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.838	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.264	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	44.7	KM Standard Error of Mean	13.69
KM SD	38.43	95% KM (BCA) UCL	64.58
95% KM (t) UCL	70.16	95% KM (Percentile Bootstrap) UCL	65.1
95% KM (z) UCL	67.22	95% KM Bootstrap t UCL	69.66
90% KM Chebyshev UCL	85.78	95% KM Chebyshev UCL	104.4
97.5% KM Chebyshev UCL	130.2	99% KM Chebyshev UCL	181

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.638	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.734	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.298	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.301	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.118	k star (bias corrected MLE)	0.782
Theta hat (MLE)	44.55	Theta star (bias corrected MLE)	63.68
nu hat (MLE)	17.88	nu star (bias corrected)	12.51
Mean (detects)	49.79		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	44.26
Maximum	101	Median	27.8
SD	41.28	CV	0.933
k hat (MLE)	0.496	k star (bias corrected MLE)	0.405
Theta hat (MLE)	89.18	Theta star (bias corrected MLE)	109.3
nu hat (MLE)	8.933	nu star (bias corrected)	7.288
Adjusted Level of Significance (β)	0.0231		
Approximate Chi Square Value (7.29, α)	2.33	Adjusted Chi Square Value (7.29, β)	1.784
95% Gamma Approximate UCL (use when n>=50)	138.4	95% Gamma Adjusted UCL (use when n<50)	180.8

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	44.7	SD (KM)	38.43
Variance (KM)	1477	SE of Mean (KM)	13.69
k hat (KM)	1.353	k star (KM)	0.976
nu hat (KM)	24.35	nu star (KM)	17.57
theta hat (KM)	33.04	theta star (KM)	45.79
80% gamma percentile (KM)	72.08	90% gamma percentile (KM)	103.5
95% gamma percentile (KM)	135.1	99% gamma percentile (KM)	208.4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (17.57, α)	9.081	Adjusted Chi Square Value (17.57, β)	7.827
95% Gamma Approximate KM-UCL (use when n>=50)	86.49	95% Gamma Adjusted KM-UCL (use when n<50)	100.3

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.838	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.283	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Detected Data Not Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	44.44	Mean in Log Scale	3.075
SD in Original Scale	41.06	SD in Log Scale	1.51
95% t UCL (assumes normality of ROS data)	69.89	95% Percentile Bootstrap UCL	66.12
95% BCA Bootstrap UCL	69.39	95% Bootstrap t UCL	71.33
95% H-UCL (Log ROS)	737.2		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	3.175	KM Geo Mean	23.92
KM SD (logged)	1.263	95% Critical H Value (KM-Log)	3.851
KM Standard Error of Mean (logged)	0.45	95% H-UCL (KM -Log)	296.5
KM SD (logged)	1.263	95% Critical H Value (KM-Log)	3.851
KM Standard Error of Mean (logged)	0.45		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	44.48	Mean in Log Scale	3.098
SD in Original Scale	41.01	SD in Log Scale	1.469
95% t UCL (Assumes normality)	69.9	95% H-Stat UCL	627.7

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	70.16

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F5, Table 8. ProUCL Output - Shellfish (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Cadmium (mg/kg)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	18
Number of Detects	18	Number of Non-Detects	3
Number of Distinct Detects	15	Number of Distinct Non-Detects	3
Minimum Detect	0.042	Minimum Non-Detect	0.56
Maximum Detect	1.6	Maximum Non-Detect	1.54
Variance Detects	0.21	Percent Non-Detects	14.29%
Mean Detects	0.432	SD Detects	0.458
Median Detects	0.29	CV Detects	1.059
Skewness Detects	1.526	Kurtosis Detects	1.443
Mean of Logged Detects	-1.342	SD of Logged Detects	1.048

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.272	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.405	KM Standard Error of Mean	0.0977
KM SD	0.426	95% KM (BCA) UCL	0.562
95% KM (t) UCL	0.574	95% KM (Percentile Bootstrap) UCL	0.571
95% KM (z) UCL	0.566	95% KM Bootstrap t UCL	0.649
90% KM Chebyshev UCL	0.698	95% KM Chebyshev UCL	0.831
97.5% KM Chebyshev UCL	1.015	99% KM Chebyshev UCL	1.377

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.563	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.764	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.177	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.209	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.13	k star (bias corrected MLE)	0.978
Theta hat (MLE)	0.383	Theta star (bias corrected MLE)	0.442
nu hat (MLE)	40.67	nu star (bias corrected)	35.23
Mean (detects)	0.432		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.042	Mean	0.4
Maximum	1.6	Median	0.264
SD	0.43	CV	1.075
k hat (MLE)	1.222	k star (bias corrected MLE)	1.079
Theta hat (MLE)	0.328	Theta star (bias corrected MLE)	0.371
nu hat (MLE)	51.33	nu star (bias corrected)	45.33
Adjusted Level of Significance (β)	0.0383		
Approximate Chi Square Value (45.33, α)	30.88	Adjusted Chi Square Value (45.33, β)	29.97
95% Gamma Approximate UCL (use when n>=50)	0.588	95% Gamma Adjusted UCL (use when n<50)	0.605

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.405	SD (KM)	0.426
Variance (KM)	0.182	SE of Mean (KM)	0.0977
k hat (KM)	0.904	k star (KM)	0.806
nu hat (KM)	37.96	nu star (KM)	33.87
theta hat (KM)	0.448	theta star (KM)	0.503
80% gamma percentile (KM)	0.662	90% gamma percentile (KM)	0.984
95% gamma percentile (KM)	1.311	99% gamma percentile (KM)	2.084

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (33.87, α)	21.56	Adjusted Chi Square Value (33.87, β)	20.81
95% Gamma Approximate KM-UCL (use when n>=50)	0.637	95% Gamma Adjusted KM-UCL (use when n<50)	0.66

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.146	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.398	Mean in Log Scale	-1.389
SD in Original Scale	0.431	SD in Log Scale	0.974
95% t UCL (assumes normality of ROS data)	0.56	95% Percentile Bootstrap UCL	0.55
95% BCA Bootstrap UCL	0.599	95% Bootstrap t UCL	0.642
95% H-UCL (Log ROS)	0.696		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.398	KM Geo Mean	0.247
KM SD (logged)	0.997	95% Critical H Value (KM-Log)	2.56
KM Standard Error of Mean (logged)	0.235	95% H-UCL (KM -Log)	0.719
KM SD (logged)	0.997	95% Critical H Value (KM-Log)	2.56
KM Standard Error of Mean (logged)	0.235		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.434	Mean in Log Scale	-1.283
SD in Original Scale	0.431	SD in Log Scale	0.994
95% t UCL (Assumes normality)	0.597	95% H-Stat UCL	0.803

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	0.66

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper (mg/kg)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	20
Number of Detects	20	Number of Non-Detects	1
Number of Distinct Detects	19	Number of Distinct Non-Detects	1
Minimum Detect	0.44	Minimum Non-Detect	3.52
Maximum Detect	6.55	Maximum Non-Detect	3.52
Variance Detects	2.537	Percent Non-Detects	4.762%
Mean Detects	2.621	SD Detects	1.593
Median Detects	2.29	CV Detects	0.608
Skewness Detects	0.594	Kurtosis Detects	0.0688
Mean of Logged Detects	0.747	SD of Logged Detects	0.729

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.905	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.192	Detected Data Not Normal at 5% Significance Level	

Detected Data appear Approximate Normal at 5% Significance Level

Appendix F5, Table 8. ProUCL Output - Shellfish (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.578	KM Standard Error of Mean	0.348
KM SD	1.541	95% KM (BCA) UCL	3.093
95% KM (t) UCL	3.179	95% KM (Percentile Bootstrap) UCL	3.153
95% KM (z) UCL	3.151	95% KM Bootstrap t UCL	3.214
90% KM Chebyshev UCL	3.623	95% KM Chebyshev UCL	4.097
97.5% KM Chebyshev UCL	4.754	99% KM Chebyshev UCL	6.045

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.595	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.196	Detected Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.467	k star (bias corrected MLE)	2.13
Theta hat (MLE)	1.063	Theta star (bias corrected MLE)	1.23
nu hat (MLE)	98.67	nu star (bias corrected)	85.2
Mean (detects)	2.621		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.44	Mean	2.576
Maximum	6.55	Median	1.8
SD	1.566	CV	0.608
k hat (MLE)	2.537	k star (bias corrected MLE)	2.206
Theta hat (MLE)	1.015	Theta star (bias corrected MLE)	1.168
nu hat (MLE)	106.6	nu star (bias corrected)	92.67
Adjusted Level of Significance (β)	0.0383		
Approximate Chi Square Value (92.67, α)	71.47	Adjusted Chi Square Value (92.67, β)	70.04
95% Gamma Approximate UCL (use when n>=50)	3.34	95% Gamma Adjusted UCL (use when n<50)	3.408

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.578	SD (KM)	1.541
Variance (KM)	2.376	SE of Mean (KM)	0.348
k hat (KM)	2.798	k star (KM)	2.43
nu hat (KM)	117.5	nu star (KM)	102
theta hat (KM)	0.922	theta star (KM)	1.061
80% gamma percentile (KM)	3.771	90% gamma percentile (KM)	4.793
95% gamma percentile (KM)	5.757	99% gamma percentile (KM)	7.872

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (102.04, α)	79.74	Adjusted Chi Square Value (102.04, β)	78.22
95% Gamma Approximate KM-UCL (use when n>=50)	3.299	95% Gamma Adjusted KM-UCL (use when n<50)	3.363

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.905	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.206	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.192	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.567	Mean in Log Scale	0.731
SD in Original Scale	1.572	SD in Log Scale	0.715
95% t UCL (assumes normality of ROS data)	3.159	95% Percentile Bootstrap UCL	3.145
95% BCA Bootstrap UCL	3.172	95% Bootstrap t UCL	3.225
95% H-UCL (Log ROS)	3.814		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.73	KM Geo Mean	2.074
KM SD (logged)	0.71	95% Critical H Value (KM-Log)	2.202
KM Standard Error of Mean (logged)	0.162	95% H-UCL (KM -Log)	3.787
KM SD (logged)	0.71	95% Critical H Value (KM-Log)	2.202
KM Standard Error of Mean (logged)	0.162		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.58	Mean in Log Scale	0.739
SD in Original Scale	1.564	SD in Log Scale	0.712
95% t UCL (Assumes normality)	3.169	95% H-Stat UCL	3.829

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL 3.179

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead (mg/kg)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	21
Number of Detects	19	Number of Non-Detects	2
Number of Distinct Detects	19	Number of Distinct Non-Detects	2
Minimum Detect	0.23	Minimum Non-Detect	4.53
Maximum Detect	20.8	Maximum Non-Detect	4.67
Variance Detects	23.26	Percent Non-Detects	9.524%
Mean Detects	2.002	SD Detects	4.822
Median Detects	0.59	CV Detects	2.409
Skewness Detects	3.735	Kurtosis Detects	14.48
Mean of Logged Detects	-0.335	SD of Logged Detects	1.13

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.391	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.453	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.866	KM Standard Error of Mean	1.006
KM SD	4.485	95% KM (BCA) UCL	3.526
95% KM (t) UCL	3.601	95% KM (Percentile Bootstrap) UCL	3.512
95% KM (z) UCL	3.521	95% KM Bootstrap t UCL	21.92
90% KM Chebyshev UCL	4.884	95% KM Chebyshev UCL	6.25
97.5% KM Chebyshev UCL	8.147	99% KM Chebyshev UCL	11.87

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.141	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.793	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.355	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.208	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.6	k star (bias corrected MLE)	0.541
Theta hat (MLE)	3.335	Theta star (bias corrected MLE)	3.703
nu hat (MLE)	22.82	nu star (bias corrected)	20.55
Mean (detects)	2.002		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.123	Mean	1.823
Maximum	20.8	Median	0.56
SD	4.61	CV	2.528
k hat (MLE)	0.565	k star (bias corrected MLE)	0.516
Theta hat (MLE)	3.226	Theta star (bias corrected MLE)	3.532
nu hat (MLE)	23.74	nu star (bias corrected)	21.68
Adjusted Level of Significance (β)	0.0383		
Approximate Chi Square Value (21.68, α)	12.1	Adjusted Chi Square Value (21.68, β)	11.55
95% Gamma Approximate UCL (use when n>=50)	3.267	95% Gamma Adjusted UCL (use when n<50)	3.422

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.866	SD (KM)	4.485
Variance (KM)	20.12	SE of Mean (KM)	1.006
k hat (KM)	0.173	k star (KM)	0.18
nu hat (KM)	7.273	nu star (KM)	7.568
theta hat (KM)	10.78	theta star (KM)	10.36
80% gamma percentile (KM)	2.317	90% gamma percentile (KM)	5.629
95% gamma percentile (KM)	9.871	99% gamma percentile (KM)	21.76

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.57, α)	2.487	Adjusted Chi Square Value (7.57, β)	2.269
95% Gamma Approximate KM-UCL (use when n>=50)	5.679	95% Gamma Adjusted KM-UCL (use when n<50)	6.225

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.775	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.901	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.235	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.197	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.869	Mean in Log Scale	-0.35
SD in Original Scale	4.594	SD in Log Scale	1.073
95% t UCL (assumes normality of ROS data)	3.598	95% Percentile Bootstrap UCL	3.753
95% BCA Bootstrap UCL	4.7	95% Bootstrap t UCL	25.55
95% H-UCL (Log ROS)	2.374		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.367	KM Geo Mean	0.693
KM SD (logged)	1.062	95% Critical H Value (KM-Log)	2.649
KM Standard Error of Mean (logged)	0.241	95% H-UCL (KM -Log)	2.284
KM SD (logged)	1.062	95% Critical H Value (KM-Log)	2.649
KM Standard Error of Mean (logged)	0.241		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.03	Mean in Log Scale	-0.224
SD in Original Scale	4.576	SD in Log Scale	1.128
95% t UCL (Assumes normality)	3.753	95% H-Stat UCL	3.017

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	6.25

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	19
Number of Detects	17	Number of Non-Detects	4
Number of Distinct Detects	15	Number of Distinct Non-Detects	4
Minimum Detect	0.1	Minimum Non-Detect	1.4
Maximum Detect	0.61	Maximum Non-Detect	3.89
Variance Detects	0.0264	Percent Non-Detects	19.05%
Mean Detects	0.331	SD Detects	0.162
Median Detects	0.37	CV Detects	0.491
Skewness Detects	0.112	Kurtosis Detects	-1.335
Mean of Logged Detects	-1.244	SD of Logged Detects	0.567

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.147	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.207	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.331	KM Standard Error of Mean	0.0394
KM SD	0.158	95% KM (BCA) UCL	0.399
95% KM (t) UCL	0.399	95% KM (Percentile Bootstrap) UCL	0.392
95% KM (z) UCL	0.395	95% KM Bootstrap t UCL	0.404
90% KM Chebyshev UCL	0.449	95% KM Chebyshev UCL	0.502
97.5% KM Chebyshev UCL	0.577	99% KM Chebyshev UCL	0.723

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.513	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.183	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.21	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.815	k star (bias corrected MLE)	3.181
Theta hat (MLE)	0.0867	Theta star (bias corrected MLE)	0.104
nu hat (MLE)	129.7	nu star (bias corrected)	108.1
Mean (detects)	0.331		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.1	Mean	0.326
Maximum	0.61	Median	0.308
SD	0.146	CV	0.446
k hat (MLE)	4.661	k star (bias corrected MLE)	4.027
Theta hat (MLE)	0.07	Theta star (bias corrected MLE)	0.081
nu hat (MLE)	195.8	nu star (bias corrected)	169.1
Adjusted Level of Significance (β)	0.0383		
Approximate Chi Square Value (169.12, α)	140	Adjusted Chi Square Value (169.12, β)	138
95% Gamma Approximate UCL (use when n>=50)	0.394	95% Gamma Adjusted UCL (use when n<50)	0.4

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.331	SD (KM)	0.158
Variance (KM)	0.0248	SE of Mean (KM)	0.0394
k hat (KM)	4.4	k star (KM)	3.803
nu hat (KM)	184.8	nu star (KM)	159.7
theta hat (KM)	0.0751	theta star (KM)	0.0869
80% gamma percentile (KM)	0.458	90% gamma percentile (KM)	0.558
95% gamma percentile (KM)	0.65	99% gamma percentile (KM)	0.846

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (159.72, α)	131.5	Adjusted Chi Square Value (159.72, β)	129.5
95% Gamma Approximate KM-UCL (use when n>=50)	0.402	95% Gamma Adjusted KM-UCL (use when n<50)	0.408

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.199	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.207	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.323	Mean in Log Scale	-1.244
SD in Original Scale	0.146	SD in Log Scale	0.508
95% t UCL (assumes normality of ROS data)	0.378	95% Percentile Bootstrap UCL	0.373
95% BCA Bootstrap UCL	0.376	95% Bootstrap t UCL	0.38
95% H-UCL (Log ROS)	0.411		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.244	KM Geo Mean	0.288
KM SD (logged)	0.551	95% Critical H Value (KM-Log)	2.036
KM Standard Error of Mean (logged)	0.138	95% H-UCL (KM -Log)	0.431
KM SD (logged)	0.551	95% Critical H Value (KM-Log)	2.036
KM Standard Error of Mean (logged)	0.138		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.462	Mean in Log Scale	-1.023
SD in Original Scale	0.394	SD in Log Scale	0.716
95% t UCL (Assumes normality)	0.611	95% H-Stat UCL	0.661

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.399

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	9	Number of Distinct Observations	8
Number of Detects	5	Number of Non-Detects	4
Number of Distinct Detects	5	Number of Distinct Non-Detects	3

Minimum Detect	0.22	Minimum Non-Detect	2.89
Maximum Detect	0.72	Maximum Non-Detect	8.02
Variance Detects	0.0434	Percent Non-Detects	44.44%
Mean Detects	0.578	SD Detects	0.208
Median Detects	0.68	CV Detects	0.361
Skewness Detects	-1.849	Kurtosis Detects	3.379
Mean of Logged Detects	-0.629	SD of Logged Detects	0.503

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.761	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.578	KM Standard Error of Mean	0.0932
KM SD	0.186	95% KM (BCA) UCL	0.7
95% KM (t) UCL	0.751	95% KM (Percentile Bootstrap) UCL	0.7
95% KM (z) UCL	0.731	95% KM Bootstrap t UCL	0.709
90% KM Chebyshev UCL	0.858	95% KM Chebyshev UCL	0.984
97.5% KM Chebyshev UCL	1.16	99% KM Chebyshev UCL	1.505

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.823	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.68	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.339	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.358	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	6.317	k star (bias corrected MLE)	2.66
Theta hat (MLE)	0.0915	Theta star (bias corrected MLE)	0.217
nu hat (MLE)	63.17	nu star (bias corrected)	26.6
Mean (detects)	0.578		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.22	Mean	0.573
Maximum	0.72	Median	0.57
SD	0.155	CV	0.271
k hat (MLE)	10.47	k star (bias corrected MLE)	7.054
Theta hat (MLE)	0.0547	Theta star (bias corrected MLE)	0.0813
nu hat (MLE)	188.4	nu star (bias corrected)	127
Adjusted Level of Significance (β)	0.0231		
Approximate Chi Square Value (126.96, α)	101.9	Adjusted Chi Square Value (126.96, β)	97.21
95% Gamma Approximate UCL (use when n>=50)	0.714	95% Gamma Adjusted UCL (use when n<50)	0.748

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.578	SD (KM)	0.186
Variance (KM)	0.0347	SE of Mean (KM)	0.0932
k hat (KM)	9.618	k star (KM)	6.486
nu hat (KM)	173.1	nu star (KM)	116.7
theta hat (KM)	0.0601	theta star (KM)	0.0891
80% gamma percentile (KM)	0.755	90% gamma percentile (KM)	0.881
95% gamma percentile (KM)	0.995	99% gamma percentile (KM)	1.232

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (116.75, α)	92.8	Adjusted Chi Square Value (116.75, β)	88.3
95% Gamma Approximate KM-UCL (use when n>=50)	0.727	95% Gamma Adjusted KM-UCL (use when n<50)	0.764

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.693	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.353	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.561	Mean in Log Scale	-0.629
SD in Original Scale	0.162	SD in Log Scale	0.375
95% t UCL (assumes normality of ROS data)	0.662	95% Percentile Bootstrap UCL	0.639
95% BCA Bootstrap UCL	0.627	95% Bootstrap t UCL	0.643
95% H-UCL (Log ROS)	0.755		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.629	KM Geo Mean	0.533
KM SD (logged)	0.45	95% Critical H Value (KM-Log)	2.184
KM Standard Error of Mean (logged)	0.225	95% H-UCL (KM -Log)	0.834
KM SD (logged)	0.45	95% Critical H Value (KM-Log)	2.184
KM Standard Error of Mean (logged)	0.225		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.259	Mean in Log Scale	-0.0651
SD in Original Scale	1.13	SD in Log Scale	0.817
95% t UCL (Assumes normality)	1.96	95% H-Stat UCL	2.979

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.751

Warning: Recommended UCL exceeds the maximum observation

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Zinc (mg/kg)

General Statistics

Total Number of Observations	21	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	17	Mean	194.8
Maximum	1080	Median	57
SD	294	Std. Error of Mean	64.16
Coefficient of Variation	1.51	Skewness	2.003

Normal GOF Test

Shapiro Wilk Test Statistic	0.638	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.362	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.188	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Appendix F5, Table 8. ProUCL Output - Shellfish (Lower Spring River)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	305.4	95% Adjusted-CLT UCL (Chen-1995)	330.3
		95% Modified-t UCL (Johnson-1978)	310.1

Gamma GOF Test

A-D Test Statistic	1.76	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.787	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.282	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.198	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.703	k star (bias corrected MLE)	0.634
Theta hat (MLE)	277.1	Theta star (bias corrected MLE)	307.1
nu hat (MLE)	29.52	nu star (bias corrected)	26.63
MLE Mean (bias corrected)	194.8	MLE Sd (bias corrected)	244.6
		Approximate Chi Square Value (0.05)	15.87
Adjusted Level of Significance	0.0383	Adjusted Chi Square Value	15.23

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	326.9	95% Adjusted Gamma UCL (use when n<50)	340.6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.891	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.908	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.194	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.188	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.833	Mean of logged Data	4.412
Maximum of Logged Data	6.985	SD of logged Data	1.26

Assuming Lognormal Distribution

95% H-UCL	417.3	90% Chebyshev (MVUE) UCL	336.7
95% Chebyshev (MVUE) UCL	411.6	97.5% Chebyshev (MVUE) UCL	515.5
99% Chebyshev (MVUE) UCL	719.6		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	300.3	95% Jackknife UCL	305.4
95% Standard Bootstrap UCL	297	95% Bootstrap-t UCL	369.9
95% Hall's Bootstrap UCL	306.8	95% Percentile Bootstrap UCL	309.5
95% BCA Bootstrap UCL	321.1		
90% Chebyshev(Mean, Sd) UCL	387.3	95% Chebyshev(Mean, Sd) UCL	474.4
97.5% Chebyshev(Mean, Sd) UCL	595.5	99% Chebyshev(Mean, Sd) UCL	833.2

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	474.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F5, Table 9. ProUCL Output - Aquatic Plants as Food (Lost Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/8/2019 2:01:09 PM
From File	TCOU5 ProUCL Tables 190506_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Barium (mg/kg)

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	2.7	Mean	16.16
Maximum	32	Median	14.8
SD	10.83	Std. Error of Mean	4.842
Coefficient of Variation	0.67	Skewness	0.486

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.168	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	26.48	95% Adjusted-CLT UCL (Chen-1995)	25.25
		95% Modified-t UCL (Johnson-1978)	26.66

Gamma GOF Test

A-D Test Statistic	0.252	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.684	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.214	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.029	k star (bias corrected MLE)	0.945
Theta hat (MLE)	7.964	Theta star (bias corrected MLE)	17.1
nu hat (MLE)	20.29	nu star (bias corrected)	9.45
MLE Mean (bias corrected)	16.16	MLE Sd (bias corrected)	16.62
		Approximate Chi Square Value (0.05)	3.601
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	2.212

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	42.41	95% Adjusted Gamma UCL (use when n<50)	69.04

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.905	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.268	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.343	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	2.516
Maximum of Logged Data	3.466	SD of logged Data	0.933

Assuming Lognormal Distribution

95% H-UCL	164.6	90% Chebyshev (MVUE) UCL	38
95% Chebyshev (MVUE) UCL	47.42	97.5% Chebyshev (MVUE) UCL	60.48
99% Chebyshev (MVUE) UCL	86.15		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	24.12	95% Jackknife UCL	26.48
95% Standard Bootstrap UCL	23.19	95% Bootstrap-t UCL	28.19
95% Hall's Bootstrap UCL	35.48	95% Percentile Bootstrap UCL	23.68
95% BCA Bootstrap UCL	23.68		
90% Chebyshev(Mean, Sd) UCL	30.69	95% Chebyshev(Mean, Sd) UCL	37.27
97.5% Chebyshev(Mean, Sd) UCL	46.4	99% Chebyshev(Mean, Sd) UCL	64.34

Suggested UCL to Use

95% Student's-t UCL 26.48

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Cadmium (mg/kg)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	7
		Number of Missing Observations	0
Minimum	0.05	Mean	0.231
Maximum	0.36	Median	0.223
SD	0.107	Std. Error of Mean	0.0377
Coefficient of Variation	0.462	Skewness	-0.435

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.173	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.283	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.302	95% Adjusted-CLT UCL (Chen-1995)	0.287
		95% Modified-t UCL (Johnson-1978)	0.301

Gamma GOF Test

A-D Test Statistic	0.427	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.72	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.25	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.296	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.651	k star (bias corrected MLE)	2.365
Theta hat (MLE)	0.0632	Theta star (bias corrected MLE)	0.0976
nu hat (MLE)	58.42	nu star (bias corrected)	37.84
MLE Mean (bias corrected)	0.231	MLE Sd (bias corrected)	0.15
		Approximate Chi Square Value (0.05)	24.76
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	22.12

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0.353	95% Adjusted Gamma UCL (use when n<50)	0.395

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.839	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.28	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.996	Mean of logged Data	-1.61
Maximum of Logged Data	-1.022	SD of logged Data	0.651

Assuming Lognormal Distribution

95% H-UCL	0.472	90% Chebyshev (MVUE) UCL	0.408
95% Chebyshev (MVUE) UCL	0.484	97.5% Chebyshev (MVUE) UCL	0.589
99% Chebyshev (MVUE) UCL	0.797		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.293	95% Jackknife UCL	0.302
95% Standard Bootstrap UCL	0.289	95% Bootstrap-t UCL	0.299
95% Hall's Bootstrap UCL	0.285	95% Percentile Bootstrap UCL	0.288
95% BCA Bootstrap UCL	0.285		
90% Chebyshev(Mean, Sd) UCL	0.344	95% Chebyshev(Mean, Sd) UCL	0.395
97.5% Chebyshev(Mean, Sd) UCL	0.466	99% Chebyshev(Mean, Sd) UCL	0.605

Suggested UCL to Use

95% Student's-t UCL	0.302

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Copper (mg/kg)

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.66	Mean	2.046
Maximum	3.56	Median	1.92
SD	1.143	Std. Error of Mean	0.511
Coefficient of Variation	0.559	Skewness	0.224

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.144	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.343	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Appendix F5, Table 9. ProUCL Output - Aquatic Plants as Food (Lost Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.135	95% Adjusted-CLT UCL (Chen-1995)	2.941
		95% Modified-t UCL (Johnson-1978)	3.144

Gamma GOF Test

A-D Test Statistic	0.188	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.682	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.174	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.359	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.41	k star (bias corrected MLE)	1.497
Theta hat (MLE)	0.6	Theta star (bias corrected MLE)	1.366
nu hat (MLE)	34.1	nu star (bias corrected)	14.97
MLE Mean (bias corrected)	2.046	MLE Sd (bias corrected)	1.672
		Approximate Chi Square Value (0.05)	7.244
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	5.071

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.229	95% Adjusted Gamma UCL (use when n<50)	6.042

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.154	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.343	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.416	Mean of logged Data	0.562
Maximum of Logged Data	1.27	SD of logged Data	0.659

Assuming Lognormal Distribution

95% H-UCL	6.927	90% Chebyshev (MVUE) UCL	3.886
95% Chebyshev (MVUE) UCL	4.705	97.5% Chebyshev (MVUE) UCL	5.842
99% Chebyshev (MVUE) UCL	8.074		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.887	95% Jackknife UCL	3.135
95% Standard Bootstrap UCL	2.813	95% Bootstrap-t UCL	3.382
95% Hall's Bootstrap UCL	3.606	95% Percentile Bootstrap UCL	2.792
95% BCA Bootstrap UCL	2.792		
90% Chebyshev(Mean, Sd) UCL	3.579	95% Chebyshev(Mean, Sd) UCL	4.274
97.5% Chebyshev(Mean, Sd) UCL	5.237	99% Chebyshev(Mean, Sd) UCL	7.131

Suggested UCL to Use

95% Student's-t UCL	3.135

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F5, Table 9. ProUCL Output - Aquatic Plants as Food (Lost Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lead (mg/kg)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	0.43	Mean	1.903
Maximum	5.2	Median	1.635
SD	1.517	Std. Error of Mean	0.536
Coefficient of Variation	0.797	Skewness	1.649

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.832	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.239	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.919	95% Adjusted-CLT UCL (Chen-1995)	3.119
		95% Modified-t UCL (Johnson-1978)	2.971

Gamma GOF Test

A-D Test Statistic	0.281	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.724	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.166	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.297	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.082	k star (bias corrected MLE)	1.385
Theta hat (MLE)	0.914	Theta star (bias corrected MLE)	1.374
nu hat (MLE)	33.31	nu star (bias corrected)	22.15
MLE Mean (bias corrected)	1.903	MLE Sd (bias corrected)	1.617
		Approximate Chi Square Value (0.05)	12.45
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	10.66

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.384	95% Adjusted Gamma UCL (use when n<50)	3.953

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.181	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.844	Mean of logged Data	0.384
Maximum of Logged Data	1.649	SD of logged Data	0.779

Assuming Lognormal Distribution

95% H-UCL	4.676	90% Chebyshev (MVUE) UCL	3.499
95% Chebyshev (MVUE) UCL	4.223	97.5% Chebyshev (MVUE) UCL	5.228
99% Chebyshev (MVUE) UCL	7.202		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.785	95% Jackknife UCL	2.919
95% Standard Bootstrap UCL	2.727	95% Bootstrap-t UCL	3.546
95% Hall's Bootstrap UCL	6.411	95% Percentile Bootstrap UCL	2.793
95% BCA Bootstrap UCL	3.008		
90% Chebyshev(Mean, Sd) UCL	3.511	95% Chebyshev(Mean, Sd) UCL	4.24
97.5% Chebyshev(Mean, Sd) UCL	5.252	99% Chebyshev(Mean, Sd) UCL	7.239

Suggested UCL to Use

95% Student's-t UCL 2.919

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Nickel (mg/kg)

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	0.3	Mean	0.878
Maximum	1.69	Median	0.54
SD	0.602	Std. Error of Mean	0.269
Coefficient of Variation	0.686	Skewness	0.681

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.868	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.313	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.452	95% Adjusted-CLT UCL (Chen-1995)	1.408
		95% Modified-t UCL (Johnson-1978)	1.466

Gamma GOF Test

A-D Test Statistic	0.399	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.683	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.297	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.36	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.64	k star (bias corrected MLE)	1.189
Theta hat (MLE)	0.333	Theta star (bias corrected MLE)	0.738
nu hat (MLE)	26.4	nu star (bias corrected)	11.89
MLE Mean (bias corrected)	0.878	MLE Sd (bias corrected)	0.805
		Approximate Chi Square Value (0.05)	5.156
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	3.401

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.025	95% Adjusted Gamma UCL (use when n<50)	3.07

Appendix F5, Table 9. ProUCL Output - Aquatic Plants as Food (Lost Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.917	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.254	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.343	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-1.204	Mean of logged Data	-0.331
Maximum of Logged Data	0.525	SD of logged Data	0.719

Assuming Lognormal Distribution

95% H-UCL	3.564	90% Chebyshev (MVUE) UCL	1.707
95% Chebyshev (MVUE) UCL	2.082	97.5% Chebyshev (MVUE) UCL	2.604
99% Chebyshev (MVUE) UCL	3.628		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.321	95% Jackknife UCL	1.452
95% Standard Bootstrap UCL	1.274	95% Bootstrap-t UCL	3.085
95% Hall's Bootstrap UCL	7.469	95% Percentile Bootstrap UCL	1.316
95% BCA Bootstrap UCL	1.316		
90% Chebyshev(Mean, Sd) UCL	1.686	95% Chebyshev(Mean, Sd) UCL	2.051
97.5% Chebyshev(Mean, Sd) UCL	2.559	99% Chebyshev(Mean, Sd) UCL	3.556

Suggested UCL to Use

95% Student's-t UCL	1.452

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Silver (mg/kg)

General Statistics

Total Number of Observations	5	Number of Distinct Observations	2
Number of Detects	1	Number of Non-Detects	4
Number of Distinct Detects	1	Number of Distinct Non-Detects	1

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Silver (mg/kg) was not processed!

Zinc (mg/kg)

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	17.5	Mean	31.09
Maximum	47.8	Median	28.5
SD	10.75	Std. Error of Mean	3.802
Coefficient of Variation	0.346	Skewness	0.51

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Appendix F5, Table 9. ProUCL Output - Aquatic Plants as Food (Lost Creek)
Tar Creek Superfund Site Operable Unit 5 Remedial Investigation
Ottawa County, Oklahoma

Normal GOF Test

Shapiro Wilk Test Statistic	0.943	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.172	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	38.29	95% Adjusted-CLT UCL (Chen-1995)	38.07
		95% Modified-t UCL (Johnson-1978)	38.41

Gamma GOF Test

A-D Test Statistic	0.205	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.715	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.294	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.673	k star (bias corrected MLE)	6.129
Theta hat (MLE)	3.214	Theta star (bias corrected MLE)	5.072
nu hat (MLE)	154.8	nu star (bias corrected)	98.06
MLE Mean (bias corrected)	31.09	MLE Sd (bias corrected)	12.56
		Approximate Chi Square Value (0.05)	76.22
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	71.36

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	40	95% Adjusted Gamma UCL (use when n<50)	42.72

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.129	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.862	Mean of logged Data	3.384
Maximum of Logged Data	3.867	SD of logged Data	0.348

Assuming Lognormal Distribution

95% H-UCL	41.42	90% Chebyshev (MVUE) UCL	42.63
95% Chebyshev (MVUE) UCL	47.86	97.5% Chebyshev (MVUE) UCL	55.11
99% Chebyshev (MVUE) UCL	69.36		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	37.34	95% Jackknife UCL	38.29
95% Standard Bootstrap UCL	36.83	95% Bootstrap-t UCL	39.78
95% Hall's Bootstrap UCL	41.09	95% Percentile Bootstrap UCL	37.39
95% BCA Bootstrap UCL	37.9		
90% Chebyshev(Mean, Sd) UCL	42.49	95% Chebyshev(Mean, Sd) UCL	47.66
97.5% Chebyshev(Mean, Sd) UCL	54.83	99% Chebyshev(Mean, Sd) UCL	68.92

Suggested UCL to Use

95% Student's-t UCL	38.29

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix F6, Table 1. Number of Game/Non-Game Fish Samples by Sample Size

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Species/Habitat	Sample Weight Quartile					Fish Tissue Lead Concentration Quartile				
	1st Qrt (<56.5 g)	2nd Qrt (≥56.5 - <110.5 g)	3rd Qrt (≥110.5 - <724.5 g)	4th Qrt (≥724.5 g)	Subtotal	1st Qrt (<0.29 mg/kg)	2nd Qrt (≥0.29 - <0.38 mg/kg)	3rd Qrt (≥0.38 - <0.48 mg/kg)	4th Qrt (≥0.48 mg/kg)	Subtotal
Game	12	12	8	4	36	11	12	9	4	36
Non Game	0	0	4	8	12	1	0	3	8	12
Subtotal	12	12	12	12	48	12	12	12	12	48
Bottom Feeder	2	3	7	11	23	3	5	7	8	23
Water Column	10	9	5	1	25	9	7	5	4	25
Subtotal	12	12	12	12	48	12	12	12	12	48

Notes:

g = gram(s)

mg/kg = milligrams per kilogram

Qrt = Quartile

Appendix F6, Table 2. Descriptive Statistics of Relative Difference in Lead Concentrations Between Head and Total Estimates by Species, Sample Weight, and Lead Concentrations in Total Fish Estimate

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Descriptive Statistics Grouped by Species										
Variable	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [a] (*p* -Value)**
Game	29	-0.138	0.738	0.336	0.235	0.174	0.357	0.483	0.657	0.527
Non Game	11	-0.415	0.929	0.407	0.469	0.138	0.558	0.74	0.893	
Descriptive Statistics Grouped by Habitat										
Variable	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [b] (*p* -Value)**
Bottom Feeder	21	-0.415	0.929	0.4	0.365	0.288	0.455	0.631	0.857	0.352
Water Column	19	-0.138	0.654	0.307	0.239	0.131	0.298	0.49	0.654	
Descriptive Statistics Grouped by Sample Weight										
Weight	**(grams)**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [c] (*p* -Value)**
1st Qrt	<56.5	11	-0.138	0.658	0.311	0.241	0.131	0.34	0.488	0.614	0.786
2nd Qrt	≥56.5 -<110.5	10	0	0.654	0.348	0.207	0.204	0.353	0.463	0.633	
3rd Qrt	≥110.5 -<724.5	7	-0.415	0.85	0.307	0.474	-0.03	0.407	0.684	0.816	
4th Qrt	≥724.5	12	-0.308	0.929	0.432	0.351	0.31	0.478	0.633	0.889	
Descriptive Statistics Grouped by Lead Concentration in Estimated Total										
Lead	**(mg/kg)**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [d] (*p* -Value)**
1st Qrt	<0.29	7	0	0.653	0.265	0.253	0.0635	0.174	0.45	0.602	0.528
2nd Qrt	≥0.29 -<0.38	9	-0.138	0.658	0.316	0.23	0.217	0.288	0.455	0.6	
3rd Qrt	≥0.38 -<0.48	12	-0.308	0.738	0.329	0.317	0.168	0.348	0.586	0.692	
4th Qrt	≥0.48	12	-0.415	0.929	0.465	0.386	0.357	0.516	0.682	0.889	

Notes:

Data were analyzed using EPA ProUCL software (Version 5.1.002) (2016).

[a] Classic ANOVA test indicates there is no statistical difference in values between Game and Non-Game species.

[b] Classic ANOVA test indicates there is no statistical difference in values between Water Column and Bottom Feeder.

[c] Classic ANOVA test indicates there is no statistical difference in values between any pairs of the four datasets grouped based on quartiles of sample weight.

[4] Classic ANOVA test indicates there is no statistical difference in values between any pairs of the four datasets grouped based on lead concentration in fish tissue (estimated total).

ANOVA = Analysis of Variance

SD = Standard Deviation

Appendix F6, Table 3. Descriptive Statistics of Relative Difference in Lead Concentrations Between Fillet and Total Estimates by Species, Sample Weight, and Lead Concentrations in Total Fish Estimate

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Descriptive Statistics Grouped by Species											
Variable		**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [a] (*p* -Value)**
Game		5	-0.61	0.205	-0.239	0.322	-0.49	-0.173	-0.129	0.138	0.292
Non Game		4	-0.774	0.08	-0.514	0.403	-0.763	-0.681	-0.432	-0.0224	
Descriptive Statistics Grouped by Habitat											
Variable		**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [b] (*p* -Value)**
Bottom Feeder		5	-0.774	0.08	-0.446	0.381	-0.759	-0.603	-0.173	0.0295	0.477
Water Column		4	-0.61	0.205	-0.256	0.369	-0.52	-0.309	-0.0456	0.155	
Descriptive Statistics Grouped by Sample Weight											
Weight	**(grams)**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [c] (*p* -Value)**
1st Qrt	<56.5	3	-0.61	0.205	-0.298	0.44	-0.55	-0.49	-0.142	0.136	0.765
3rd Qrt	≥110.5 -<724.5	2	-0.603	-0.129	-0.366	0.335	-0.484	-0.366	-0.248	-0.153	
4th Qrt	≥724.5	4	-0.774	0.08	-0.406	0.428	-0.763	-0.466	-0.109	0.0421	
Descriptive Statistics Grouped by Lead Concentration in Estimated Total											
Lead	**(mg/kg)**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [d] (*p* -Value)**
1st Qrt	<0.29	1	0.205	0.205	0.205	N/A	0.205	0.205	0.205	0.205	3.3E-04
2nd Qrt	≥0.29 -<0.38	2	-0.173	-0.129	-0.151	0.0306	-0.162	-0.151	-0.14	-0.131	
3rd Qrt	≥0.38 -<0.48	1	0.08	0.08	0.08	N/A	0.08	0.08	0.08	0.08	
4th Qrt	≥0.48	5	-0.774	-0.49	-0.647	0.119	-0.759	-0.61	-0.603	-0.512	

Notes:

Data were analyzed using EPA ProUCL software (Version 5.1.002) (2016).

[a] Classic ANOVA test indicates there is no statistical difference in values between Game and Non-Game species.

[b] Classic ANOVA test indicates there is no statistical difference in values between Water Column and Bottom Feeder.

[c] Because of the small sample counts, the data from the 1st and 3rd quartiles were merged and compared to the 4th quartile dataset.

Classic ANOVA test indicates there is no statistical difference in values between the two datasets.

[d] Because of the small sample counts, the data from the 1st, 2nd, and 3rd quartiles were merged and compared to the 4th quartile dataset.

Classic ANOVA test indicates there is statistical difference in values between the two datasets.

= statistical difference in values between the two datasets

ANOVA = Analysis of Variance

SD = Standard Deviation

Appendix F6, Table 4. Descriptive Statistics of Relative Difference in Lead Concentrations Between Carcass and Total Estimates by Species, Sample Weight, and Lead Concentrations in Total Fish Estimate

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Descriptive Statistics Grouped by Species										
Variable	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [a] (*p* -Value)**
Game	28	-0.269	0.299	0.032	0.134	-0.0742	0.0541	0.114	0.218	0.646
Non Game	11	-0.218	0.308	0.0069	0.194	-0.148	-0.0868	0.143	0.296	
Descriptive Statistics Grouped by Habitat										
Variable	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [b] (*p* -Value)**
Bottom Feeder	19	-0.269	0.308	-0.0122	0.172	-0.142	-0.077	0.117	0.287	0.136
Water Column	20	-0.22	0.299	0.0602	0.121	0.00787	0.0703	0.117	0.242	
Descriptive Statistics Grouped by Sample Weight										
Weight	**(grams)**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [c] (*p* -Value)**
1st Qrt	<56.5	11	-0.269	0.239	0.037	0.142	-0.0438	0.0746	0.106	0.204	0.219
2nd Qrt	≥56.5 -<110.5	10	-0.22	0.0797	-0.0278	0.097	-0.0634	-0.00591	0.0433	0.070	
3rd Qrt	≥110.5 -<724.5	8	-0.218	0.299	0.113	0.178	0.0763	0.158	0.205	0.294	
4th Qrt	≥724.5	10	-0.201	0.308	-0.00611	0.168	-0.123	-0.0786	0.102	0.251	
Descriptive Statistics Grouped by Lead Concentration in Estimated Total										
Lead	**(mg/kg)**	**Number of Samples**	**Minimum**	**Maximum**	**Mean**	**SD**	**25%ile (Q1)**	**50%ile (Q2)**	**75%ile (Q3)**	**95%ile**	**ANOVA [d] (*p* -Value)**
1st Qrt	<0.29	6	-0.0335	0.299	0.127	0.14	0.0287	0.0956	0.249	0.295	0.344
2nd Qrt	≥0.29 -<0.38	11	-0.269	0.239	0.0197	0.158	-0.0873	0.0585	0.15	0.207	
3rd Qrt	≥0.38 -<0.48	11	-0.22	0.308	-0.00395	0.156	-0.0843	-0.0733	0.0903	0.243	
4th Qrt	≥0.48	11	-0.218	0.182	0.00326	0.14	-0.114	0.0659	0.104	0.145	

Notes:

Data were analyzed using EPA ProUCL software (Version 5.1.002) (2016).

[a] Classic ANOVA test indicates there is no statistical difference in values between Game and Non-Game species.

[b] Classic ANOVA test indicates there is no statistical difference in values between Water Column and Bottom Feeder.

[c] Classic ANOVA test indicates there is no statistical difference in values between any pairs of the four datasets grouped based on quartiles of sample weight.

[d] Classic ANOVA test indicates there is no statistical difference in values between any pairs of the four datasets grouped based on lead concentration in fish tissue (estimated total).

ANOVA = Analysis of Variance

SD = Standard Deviation

Appendix F6, Table 5. Results of Single Sample Hypothesis Test

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

One Sample t-Test for Uncensored Full Datasets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.12/3/2020 12:42:20 AM
From File	ProUCL.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Action Level	0
Selected Null Hypothesis	Mean <= Action Level (Form 1)
Alternative Hypothesis	Mean > the Action Level

Head2

One Sample t-Test

Raw Statistics		
Number of Valid Observations	40	
Number of Distinct Observations	40	
Minimum	-0.415	
Maximum	0.929	
Mean	0.356	note [1]
Median	0.391	
SD	0.311	
SE of Mean	0.0492	

H0: Sample Mean <= 0 (Form 1)

Test Value	7.225
Degrees of Freedom	39
Critical Value (0.05)	1.685
P-Value	5.27E-09

Conclusion with Alpha = 0.05

Reject H0, Conclude Mean > (note [a]

P-Value < Alpha (0.05)

One Sample t-Test for Uncensored Full Datasets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.12/3/2020 2:20:36 AM
From File	ProUCL_b.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Action Level	0
Selected Null Hypothesis	Mean <= Action Level (Form 1)
Alternative Hypothesis	Mean > the Action Level

Fillet2

One Sample t-Test

Raw Statistics	
Number of Valid Observations	9
Number of Distinct Observations	9
Minimum	-0.774
Maximum	0.205
Mean	-0.361
Median	-0.49
SD	0.366
SE of Mean	0.122

H0: Sample Mean <= 0 (Form 1)

Test Value	-2.964
Degrees of Freedom	8
Critical Value (0.05)	1.86
P-Value	9.91E-01

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Mean <= 0 note [b]

P-Value > Alpha (0.05)

One Sample t-Test for Uncensored Full Datasets without NDs

User Selected Options	
Date/Time of Computation	ProUCL 5.12/3/2020 2:30:49 AM
From File	ProUCL_c.xls
Full Precision	OFF
Confidence Coefficient	95%
Substantial Difference	0
Action Level	0
Selected Null Hypothesis	Mean <= Action Level (Form 1)
Alternative Hypothesis	Mean > the Action Level

Carcass2

One Sample t-Test

Raw Statistics	
Number of Valid Observations	39
Number of Distinct Observations	39
Minimum	-0.269
Maximum	0.308
Mean	0.0249
Median	0.0497
SD	0.151
SE of Mean	0.0241

H0: Sample Mean <= 0 (Form 1)

Test Value	1.033
Degrees of Freedom	38
Critical Value (0.05)	1.686
P-Value	1.54E-01

Conclusion with Alpha = 0.05

Do Not Reject H0, Conclude Mean <= 0 note [b]

P-Value > Alpha (0.05)

Notes:

Data were analyzed using EPA ProUCL software (Version 5.1.002) (2016).

[a] Interpretation of the results: Lead concentrations in the head of fish are statistically significantly higher (alpha = 0.05) than the estimated "total" lead concentrations in whole fish.

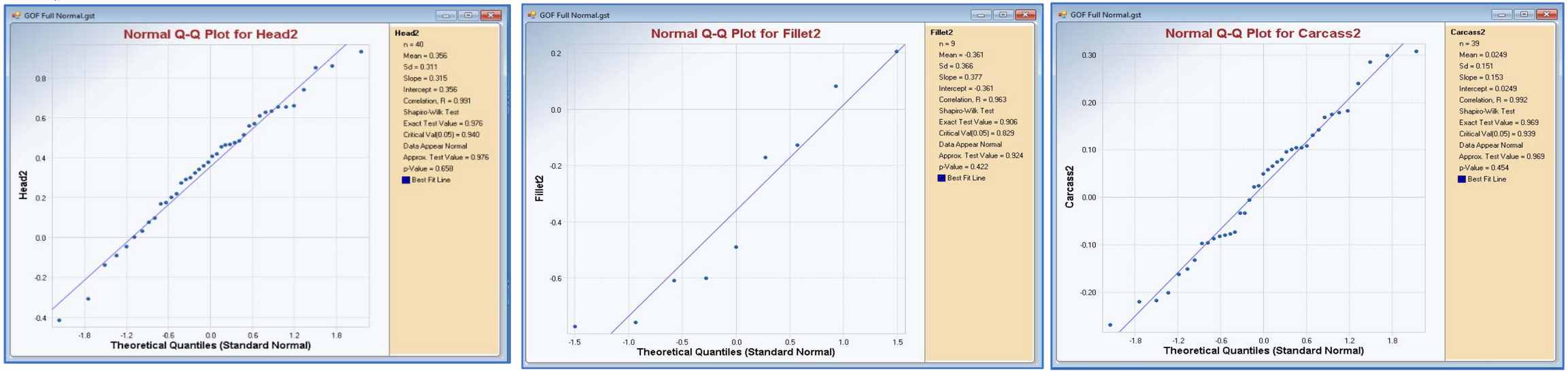
On average, lead concentrations in the head are about 35.6% higher than the estimated "total" lead concentrations in whole fish.

[b] Interpretation of the results: There is no statistically significant increase (alpha = 0.05) in lead concentrations in the fish fillet or carcass compared to the estimated "total" lead concentrations in whole fish.

Appendix F6, Figure 1. Normal Q-Q Plot and the Results for the Test of Normality

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma



Note:

Data were analyzed using EPA ProUCL software (Version 5.1.002) (2016).

Appendix F7, Table 1. Co-located Sediment and Arrowhead Root, Leaf, and Tuber Analytical Data Summary

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Exposure Media	Watershed	Elm Creek		Tar Creek		Lost Creek		Lower Spring River		Maximum Detected (mg/kg)	
	Location ID	EC AR 01		TC AR 01		LC AR 01		LS AR 01			
	Sample Date	10/31/2017		11/1/2017		10/31/2017		10/31/2017			
Sediment	**Sample ID**	EC-SD-AR-01		TC-SD-AR-01		LC-SD-AR-01		LS-SD-AR-01			
	Collection Depth (inches)	3-6		0-6		0-6		0-6			
	SamplePreparation	Unsieved		Unsieved		Unsieved		Unsieved			
	Barium	**63**	=	**160**	=	**62.7**	=	**92.6**	=	**160**	=
	Cadmium	**160**	=	**13.9**	=	0.08	UJ	**52.6**	=	**160**	=
	Copper	**492**	=	**21.2**	=	**4.6**	=	**33.3**	=	**492**	=
	Lead	**15700**	=	**199**	=	**23.5**	=	**236**	=	**15700**	=
	Nickel	**37.5**	=	**30.3**	=	**9.7**	=	**27.4**	=	**37.5**	=
	Zinc	**16400**	=	**3810**	=	**141**	=	**5210**	=	**16400**	=
Aquatic Plant Arrowhead (Root)	**Sample ID**	**EC-TS-AR-01-R**		**TC-TS-AR-01-R**		**LC-TS-AR-01-R**		**LS-TS-AR-01-R**			
	Barium	9.3	=	31	=	14.8	=	27.9	=	31	=
	Cadmium	21.2	=	0.73	=	0.21	=	2.13	=	21.2	=
	Copper	22.7	=	0.06	UJ	0.66	=	2.09	=	22.7	=
	Lead	838	=	2.53	=	1.15	J	12.1	J	838	=
	Nickel	3.58	=	0.74	=	0.52	=	2.31	=	3.58	=
	Zinc	1840	=	51.1	=	30.7	=	366	=	1840	=
Aquatic Plant Arrowhead (Leaf)	**Sample ID**	**EC-TS-AR-01-L**		**TC-TS-AR-01-L**		**LC-TS-AR-01-L**		**LS-TS-AR-01-L**			
	Barium	7.16	=	7	=	11.5	=	16.4	=	16.4	=
	Cadmium	6.62	=	0.2	=	0.21	=	0.26	=	6.62	=
	Copper	8.84	=	0.48	=	1.34	=	1.49	=	8.84	=
	Lead	304	J	1.55	=	0.93	J	3.13	J	304	J
	Nickel	1.39	=	0.51	=	0.3	=	1.17	=	1.39	=
	Zinc	793	=	46.9	=	25.2	=	132	=	793	=
Aquatic Plant Arrowhead (Tuber)	**Sample ID**					**LC-TS-AR-01-T**					
	Barium					2.7	=			2.7	=
	Cadmium					0.05	J			0.05	J
	Copper					1.92	=			1.92	=
	Lead					0.43	J			0.43	J
	Nickel					0.54	=			0.54	=
	Zinc					17.5	=			17.5	=

Notes:

Plant part with highest concentration at sample location

Plant part with second highest concentration at sample location

Plant part with highest concentration at sample location (tie)

Plant part with third highest concentration at sample location, when the 3rd sample is available

Above sediment background threshold value

Non-detected

mg/kg = milligrams per kilogram

Appendix F7, Table 2. Comparison of Noncarcinogenic Hazard Estimates between Total Plants and Leaves, Roots, and Tuber Data

Tar Creek Superfund Site Operable Unit 5 Remedial Investigation

Ottawa County, Oklahoma

Plant COPC	Target Organ Ingestion	Hazard Quotient							
		Total Plant [a]		Leaves [b]		Roots [b]		Tubers [b]	
		EPC (mg/kg)	Ingestion HQ	EPC (mg/kg)	Ingestion HQ	EPC (mg/kg)	Ingestion HQ	EPC (mg/kg)	Ingestion HQ
Barium	Urinary	2.1E+01	4.6E-01	1.6E+01	3.6E-01	3.1E+01	6.9E-01	2.7E+00	6.0E-02
Cadmium (non-water)	Urinary	1.5E+01	6.6E+01	6.6E+00	2.9E+01	2.1E+01	9.4E+01	5.0E-02	2.2E-01
Copper	Gastrointestinal	1.9E+01	2.1E+00	8.8E+00	9.8E-01	2.3E+01	2.5E+00	1.9E+00	2.1E-01
Lead	NA	7.1E+01	NA	3.0E+02	NA	8.4E+02	NA	4.3E-01	NA
Nickel	Whole Body	1.7E+00	3.8E-01	1.4E+00	3.1E-01	3.6E+00	7.9E-01	5.4E-01	1.2E-01
Zinc	Immune, Hematologic	1.4E+03	2.1E+01	7.9E+02	1.2E+01	1.8E+03	2.7E+01	1.8E+01	2.6E-01
Exposure Route Total			91		43		125		0.9
Exposure Scenario Total			91		43		125		0.9
Target Organ-Specific HI	Total Gastrointestinal HI =		2		1		3		0.2
	Total Immune HI =		21		12		27		0.3
	Total Hematologic HI =		21		12		27		0.3
	Total Urinary HI =		67		30		95		0.3
	Total Whole Body HI =		0.4		0.3		0.8		0.1

Notes:

[a] Total Plant HQ from RAGS Part D Table 9s.

[b] Leaves, Roots, and Tubers HQs are calculated using a risk ratio:
(Total Plant HQ/Total Plant EPC) x Leaves, Roots, or Tubers EPC

COPC = chemical of potential concern

EPC = exposure point concentration

HI = hazard index

HQ = hazard quotient

mg/kg = milligrams per kilogram

NA = not applicable/available

ND = not detected