BASELINE HUMAN HEALTH RISK ASSESSMENT
FOR THE
STANDARD MINE SITE
GUNNISON COUNTY, COLORADO

Prepared for, and with oversight by:
U.S. Environmental Protection Agency Region 8
1595 Wynkoop Street
Denver, Colorado 80202

Prepared by:
Syracuse Research Corporation
999 18th Street, Suite 1975
Denver, Colorado 80202

March 19, 2008

This page intentionally left blank to facilitate double-sided printing.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AFs	Absorption fraction
AT	Averaging Time
ATV	All Terrain Vehicle
ATSDR	Agency for Toxic Substances and Disease Registry
BHHRA	Baseline Human Heath Risk Assessment
BKSF	Biokinetic Slope Factor
BW	Body Weight
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
CTE	Central Tendency Exposure
DI	Daily Intake
DIL	Daily Intake averaged over a lifetime
ED	Exposure Duration
EF	Exposure Frequency
EPC	Exposure Point Concentration
GM	Geometric Mean
GSD	Geometric Standard Deviation
HI	Hazard Index
HIF	Human Intake Factor
HQ	Hazard Quotient
IR	Intake Rate
IRIS	Integrated Risk Information System
LOAEL	Lowest-observed-adverse-effect-level
NOAEL	No-observed-adverse-effect-level
P10	The probability that a blood lead value will exceed 10 ug/dL
PbB	Blood Lead Concentration
PbS	Soil Lead concentration
PEF	Particulate Emission Factor
PPRTVs	Provisional Peer Reviewed Toxicity Values
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk-Based Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure
SF	Slope Factor
UCL	Upper Confidence Limit
USEPA	United States Environmental Protection Agency
WOE	Weight of Evidence

EXECUTIVE SUMMARY

Purpose of This Document

This document is a baseline human heath risk assessment for the Standard Mine site in Gunnison County, Colorado. The purpose of this document is to assess the potential risks to humans from site-related contaminants present in environmental media, assuming that no steps are taken to remediate the environment or to reduce human contact with contaminated environmental media.

Site Location and Description

The Standard Mine is located in the Coal Creek Watershed of the Gunnison National Forest in Gunnison County, Colorado, approximately 30 miles north of Gunnison and 5 miles west of Crested Butte.

The Coal Creek Watershed has a long history of mining. Silver mining began in 1874, but ceased by 1890 except for the Forest Queen Mine. Gold, silver, zinc, and copper mining occurred sporadically between 1901 and 1974. At present, active mining in the Coal Creek watershed has ceased.

Most of the area near the mine is heavily forested, and is managed by the U.S. Forest Service. The terrain is mountainous with incised stream valleys with steep slopes. Elevations range from a low of 8,900 feet at the town of Crested Butte, to a high of 13,000 feet along the western edge of the mining district. Standard Mine is drained by Elk Creek, which is the primary surface water drainage from the southeastern half of the mining district. Elk Creek flows primarily south, where it joins Coal Creek. Coal Creek flows eastward toward Crested Butte, where it flows into the Slate River. Coal Creek serves as the drinking water source for the town of Crested Butte.

The Standard Mine Site and nearby lands are currently used mainly for recreation. It is anticipated that land use will remain recreational in the future. The site is of potential human health concern to EPA because mining activities often result in the release of a variety of different metals to soil, surface water, and sediment, and excessive human exposure to mining-related contaminants can lead to adverse health effects.

Exposure Assessment

For the purpose of this risk assessment, the Standard Mine site was divided into two main areas: the Mine Facility Area and the Site Drainage Area. The Mine Facility Area refers to the mine workings and the disturbed areas surrounding the mine, whereas the Drainage Area refers to areas along Elk Creek and Coal Creek that may be impacted by contaminated waters or sediments released from the site.

At the Mine Facility Area, the population of chief concern consists of recreational visitors who may visit the site while engaged in a range of activities such as hiking, ATV riding, horseback riding, snowmobiling, etc. For the purposes of this assessment, two scenarios have been selected to serve as representative activities for a recreational visitor at the site:

- Hiker: The hiker is selected to represent a typical exposure at the site. The hiker population is assumed to include older children, adolescents, or adults who pass across the site while hiking in the area. The exposure pathways of primary concern for the hiker are incidental ingestion of surface soil, surface water and sediment while at the site.

- ATV Rider: ATV riders are selected because ATV riding is likely to result in higher than average exposures to on-site soils, both by incidental ingestion of surface soil and also by inhalation of dust particles that are released from soil into air by the riding activity.

For the Drainage Area, the receptors most likely to be exposed are residents from nearby communities who may visit the surface streams for recreational uses. Three populations are selected for evaluation, as described below.

- Recreational Fisherman: The recreational fisherman population represents individuals who may fish along streams flowing from the site. The primary exposure pathways for the fisherman are incidental ingestion of surface water and sediment while fishing, as well as ingestion of fish caught from the streams draining the site.

- Recreational Child Visitor: Children living in the general area of the site may visit the surface streams flowing from the site for play. This population is assumed to be comprised mainly of older children/adolescents (ages 6-12 years old). The primary exposure pathways for the child visitor are incidental ingestion of surface water and sediment while playing along the streams draining the site, as well as ingestion of fish caught from the streams draining the site.

- Camper: This population consists of individuals (both adults and older children) who may camp along Elk Creek. The primary exposure pathway is ingestion of surface water from Elk Creek used for drinking or cooking, as well as incidental ingestion of sediments from the Creek.

Selection of Chemicals of Potential Concern

Chemicals of Potential Concern (COPCs) are chemicals which exist in the environment at concentration levels that might be of potential health concern to humans and which are or might be derived, at least in part, from site-related sources.

COPCs were identified by comparing the maximum detected concentration for each analyte in each medium to a Risk-Based Concentration (RBC). If the maximum detected concentration does not exceed the RBC, it was concluded that the chemical does not pose a significant risk to humans. Application of this selection process to the data available from the site yielded the following results:

Area	Medium	COPC
On-facility Area	Soil	Aluminum, Arsenic, Cadmium, Chromium, Iron, Lead, Manganese
	Surface water	None
	Sediment	None
Site Drainages	Surface water	Arsenic, Cadmium
	Sediment	Arsenic
	Fish	Arsenic

Exposure and Risk from Non-Lead COPCs

Exposure to non-lead COPCs was evaluated using the standard equations recommended by EPA for use at Superfund sites. Data from a site-specific community interview were used to estimate frequency and duration of site visits. Other exposure parameters were based on USEPA default guidelines or on professional judgment. Exposure point concentrations in soil, sediment, water, and fish tissue were derived using EPA's ProUCL software system. Concentrations of COPCs in air during ATV riding were estimated using a screening-level soil-to-air transfer model. Toxicity values were derived from USEPA recommended sources, including an on-line database referred to as IRIS and USEPA's Superfund Technical Assistance Center.

Non-cancer risks are evaluated by computing the Hazard Index (HI). If the value of the HI is less than or equal to 1, then risks of non-cancer effects are not of concern. If the value of HI exceeds 1, then there may be a risk of non-cancer effects, with the probability and/or severity tending to increase as the values of the HI becomes larger. For cancer, risks are expressed in terms of the probability that site-related exposures will result in the occurrence of cancer. The EPA generally considers a risk level of $1x10^{-4}$ (1 in 10,000) or less to be sufficiently low that no response action is needed, although this is a judgment that may vary from site to site.

Based on this approach, the calculated cancer and non-cancer risk estimates for recreational visitors at this site are as follows:

Estimated Risks to On-Site Recreational Visitors

Receptor	Exposure Pathways	Non-Cancer Hazard Index		Excess Cancer Risk	
		CTE	RME	CTE	RME
Adult Hiker	Ingestion	0.003	0.02	$7x10^{-08}$	$2x10^{-06}$
Adult ATV rider	Ingestion + Inhalation	0.2	1	$4x10^{-07}$	$9x10^{-06}$
Child ATV rider	Ingestion + Inhalation	0.3	2	$2x10^{-07}$	$4x10^{-06}$

As seen, for the adult hiker exposed by ingestion to on-site soils and incidental ingestion of sediment, non-cancer risks are below a level of concern for both the CTE and RME receptor.

Likewise, cancer risks are below EPA's usual level of concern ($1x10^{-04}$) for both the CTE and the RME hiker.

For ATV riders exposed by ingestion and inhalation of on-site soils, non-cancer risks are below a level of concern for the CTE child and adult and the RME adult, but exceed a level of concern for the RME child. This non-cancer risk is contributed primarily by inhalation exposure to manganese in airborne dusts, with non-cancer risks from all other chemicals combined contributing an HI of 0.2. Cancer risks to ATV riders are below EPA's usual level of concern for both CTE and RME children and adults. These results indicate that health risk to on-site recreational visitors is likely to be low unless site activities frequently result in the generation of elevated levels of dust.

Risks to recreational visitors in the site drainage areas are summarized below:

Estimated Risks to Recreational Visitors Along Site Drainages

Receptor	Non-Cancer Hazard Index		Excess Cancer Risk	
	CTE	RME	CTE	RME
Adult Fisherman	0.008	0.08	$4x10^{-06}$	$1x10^{-05}$
Child Visitor	0.01	0.09	$1x10^{-07}$	$3x10^{-06}$
Adult Camper	0.004	0.02	$9x10^{-08}$	$2x10^{-06}$
Child Camper	0.005	0.03	$3x10^{-08}$	$6x10^{-07}$

As seen, non-cancer risks summed across all exposure pathways are below a level of concern for all receptors. Likewise, cancer risks summed across all pathways are below EPA's usual level of concern ($1x10^{-04}$) for all receptors.

With regard to ingestion of arsenic in fish, it should be noted that the concentration of arsenic in fish from the site is similar to what would be expected in seafood purchased from a store. In addition, the concentrations of arsenic in fish are lower in Elk Creek than in Coal Creek, especially in Coal Creek above the confluence with Elk Creek. This indicates that Standard Mine is not the source of most of the arsenic in fish.

Risk From Lead

For lead, the human population of chief concern is generally young children and pregnant women. At this site, the populations that are exposed to on-site soils include adult hikers and ATV riders, as well as older children (age 6-12) riding ATVs. Because children in this age range are not expected to become pregnant, this assessment focuses on risks to the fetus of adult women hikers or ATV riders exposed by incidental ingestion of on-site soils and/or inhalation of on-site airborne dusts.

Risks to these groups were evaluated using the adult lead model recommended by EPA. This model predicts the average blood lead level in a person with a site-related lead exposure by summing the "baseline" blood lead level (that which would occur in the absence of any site-related exposures) with the increment in blood lead that is expected as a result of increased exposure due to contact with a lead-contaminated site medium. Once the average blood lead value is calculated, the full distribution of likely blood lead values in the population of exposed people is estimated by assuming the distribution is lognormal with a specified individual geometric standard deviation. The measure of chief concern is the probability that an individual will have a blood lead level that exceeds 10 ug/dL. For convenience, this probability is referred to as P10.

Based on the exposure assumptions used for recreational visitors along with the default biokinetic parameters recommended by EPA, the adult lead model predicts that the probability of a woman visitor to the site having a blood lead level above the level of concern is very low (≤ 0.001%) for both hikers and ATV riders, and does not approach the risk based goal (P10 ≤ 5%). These results indicate that levels lead in on-site soils will not likely pose a risk to on-site recreational visitors.

Uncertainties

Quantitative evaluation of the risks to humans from environmental contamination is frequently limited by uncertainty regarding a number of key data items, including concentration levels in the environment, the true level of human contact with contaminated media, and the true dose-response curves for non-cancer and cancer effects in humans. This uncertainty is usually addressed by making assumptions or estimates for uncertain parameters based on whatever limited data are available. Because of these assumptions and estimates, the results of risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment.

With regard to non-lead COPCs at this site, the only exposure scenario of potential concern appears to be inhalation to manganese in airborne dusts generated during ATV riding. These risk estimates are uncertain because the concentration of manganese in air was not measured but was estimated using a screening-level soil-to-air transfer model. In addition, the inhalation reference dose is uncertain, as reflected by application of an uncertainty factor of 1000 in the derivation of the inhalation reference dose. Thus, risk estimates for inhalation of manganese should be considered uncertain, and true risks are more likely to be smaller than larger than the calculated risks.

With regard to lead, there are many uncertainties that influence the calculation of the P10 value, including uncertainty in the amount of soil ingested, the amount of lead absorbed, and the true values for the baseline blood lead and the geometric standard deviation of the assumed lognormal distribution of blood lead values in exposed women. However, because the calculated P10 values are well below a level of concern, there is very little uncertainty in the conclusion that lead is not a significant source of concern at this site.

1.0 INTRODUCTION

1.1 Purpose

This document is a baseline human heath risk assessment (BHHRA) for the Standard Mine site in Gunnison County, Colorado. The purpose of this document is to assess the potential risks to humans from site-related contaminants present in environmental media, assuming that no steps are taken to remediate the environment or to reduce human contact with contaminated environmental media.

The results of this assessment are intended to help inform risk managers and the public about potential human risks attributable to site-related contaminants and to help determine if there is a need for action at the site. The overall management goal is to ensure protection of humans from deleterious effects of acute and chronic exposures to site-related chemicals for current and reasonable future land uses.

The methods used to evaluate risks in this assessment are consistent with current USEPA guidelines for human health (USEPA 1989; 1991a; 1991b; 1992a; 1993; 2002a; 2002b; 2004e) provided by the USEPA for use at Superfund sites.

1.2 Organization

In addition to this introduction, this report is organized into the following sections:

Section 2	This section provides a description of the site and a review of data that characterize the nature and extent of environmental contamination at the site.
Section 3	This section identifies human exposure scenarios of potential concern at the site, and identifies chemicals of potential concern for each exposure scenario.
Section 4	This section summarizes exposure and risk to recreational visitors from chemical of potential concern other than lead in on-site soils. This include a description of the basic methods data used to evaluate exposure and risk from non-lead chemicals, the estimated cancer and noncancer risk levels at the site, and a discussion of the uncertainties in the evaluation.
Section 5	This section summarizes human exposure and risk from lead in on-site soils. This include a description of the basic methods and data used to evaluate exposure and risk, the estimated levels of risk, and a discussion of the uncertainties in the evaluation.
Section 6	This section provides full citations for USEPA guidance documents, site-related documents, and scientific publications referenced in the baseline risk assessment.

This page intentionally left blank to facilitate double-sided printing.

2.0 SITE CHARACTERIZATION

2.1 Site Location

The Standard Mine is located in the Coal Creek Watershed of the Gunnison National Forest in Gunnison County, Colorado, approximately 30 miles north of Gunnison and 5 miles west of Crested Butte. A map of the site is provided in Figure 2-1.

2.2 Site History

The Coal Creek Watershed has a long history of mining. Successive periods of mining activity have occurred in the area including precious metals extraction, coal mining, and the mining of heavy metals. Mining first began in the Irwin silver district in 1874 when the land was still a part of the Ute Indian Reservation. Silver mining activity ceased by 1890 in this area except for the Forest Queen Mine (URSOS, 1999). Gold, silver, zinc, and copper ores were sporadically to continuously mined between 1901 and 1974. The three largest producing mines were the Standard Mine, the Forest Queen Mine, and the Keystone Mine, all located on the south flank of the Scarp Ridge. The Keystone Mine was ranked third in silver production in Colorado for several years between 1955 and 1964 (URSOS, 2000). At present, active mining in the Coal Creek watershed has ceased.

2.3 Physical Setting

Most of the area near the mine is heavily forested, and is managed by the U.S. Forest Service (Stantec Consulting Ltd., 2005). The terrain is mountainous with incised stream valleys with steep slopes. Elevations range from a low of 8,900 feet above sea level at the town of Crested Butte, to a high of 13,000 feet above sea level along the Ruby Range at the western edge of the mining district.

This region is semiarid with a mean annual precipitation of 11.7 inches, mostly as snow. The net annual precipitation, as calculated from precipitation and evapotranspiration data, is 3.7 inches (URSOS 2000).

The Standard Mine site is drained by Elk Creek, which is the primary surface water drainage from the southeastern half of the mining district. Elk Creek flows primarily south and crosses County Road 12 approximately 4 miles west of Crested Butte, just before its confluence with Coal Creek. Coal Creek flows eastward from near Lake Irwin and receives waters from Forest Queen Mine, Splain's Gulch, Elk Creek, the iron fen, Keystone Mine, and Wildcat Creek before reaching the town of Crested Butte, where it flows into the Slate River (Figure 2-1). Coal Creek serves as the drinking water source for the town of Crested Butte.

2.4 Land Use

The Standard Mine Site and nearby lands are controlled by the U.S. Forest Service and are currently used mainly for recreation. Multiple use trails for horseback riding, hiking, and mountain biking exist for summer recreation and forest roads are used or cross-country skiing, snowshoeing, and snowmobiling in the winter. Motorized vehicle traffic during the summer months is high, especially along County Road 12. Off-road traffic on Forest Service roads also occurs during summer months in the watershed. It is anticipated that land use will remain recreational in the future.

The nearest areas that are currently used for permanent human residence include the towns of Irwin (about 2.5 miles southwest of the mine site) and Crested Butte (about 5 miles east of the mine site). Because of the steep nature of the terrain at the site, it is not thought that future residential development in close proximity to the site is likely to occur.

2.5 Basis for Potential Human Health Concern

Mining sites are generally associated with the occurrence of elevated levels of a number of different metals in solid mine wastes (tailings, waste rock, spilled ore, etc), as well as in surface water draining from mine shafts and adits. Excess exposures to metals are known to cause a range of non-cancer and cancer effects in humans, so visitors to the site could be at risk of adverse health effects if excessive exposure to contaminated environmental media were to occur.

2.6 Site Investigations

A number of studies have been performed to investigate and characterize the nature and extent of mining-related environmental contamination at the site and in nearby locations. Studies performed before 1995 (Colburn 1982, 1986, Moran and Wentz 1974, Rumberg et al. 1978, Wentz 1974) were not selected for use in this BHHRA because it is considered possible that the data from this time may not be representative of current site conditions. Table 2-1 provides a summary of data from studies performed after 1995, indicating the types and number of samples collected and analyzed during each investigation. All of these studies were considered to be of adequate relevance and reliability, and all data from these studies were retained for use in this evaluation.

2.7 Data Summary

The detailed analytical data used in this BHHRA are provided electronically in Appendix A. Summary statistics are provided in Table 2-2 (surface water), Table 2-3 (sediment), Table 2-4 (soil), and Table 2-5 (fish tissue). Sampling locations are presented in Figures 2-2 through 2-5 for surface soil, surface water, sediment, and fish tissue, respectively.

2.8 Response Actions

To date, only a limited set of response actions have been completed at the site. These actions include:

- dewatering the on-site tailings pond
- channelization of influent surface water to pass around on-site wastes
- removal of mining debris from the Level 1 Adit
- removal of trestle
- removal of ore bins

All of the environmental data used in this risk assessment represent conditions prior to the implementation of these response actions. Further response actions may be undertaken in the future as may be needed to protect human health and the environment.

This page intentionally left blank to facilitate double-sided printing.

3.0 EXPOSURE ASSESSMENT

3.1 Site Conceptual Model

Exposure is the process by which humans come into contact with chemicals in the environment. In general, humans can be exposed to chemicals in a variety of environmental media (e.g., soil, water, air, food), and these exposures can occur through several pathways (e.g., ingestion, dermal contact, inhalation).

For the purpose of this risk assessment, the Standard Mine site is divided into two main areas: the Mine Facility Area and the Site Drainage Area (see Figure 2-1). The Mine Facility Area refers to the mine workings and the disturbed areas surrounding the mine, whereas the Drainage Area refers to areas along Elk Creek and Coal Creek that may be impacted by contaminated waters or sediments released from the site.

Figure 3-1 is a Conceptual Site Model (CSM) that summarizes the populations and exposure scenarios of potential concern in each of these two areas. The main elements of this CSM are discussed below.

3.1.1 Populations of Chief Concern

At the Mine Facility Area, the population of chief concern consists of recreational visitors who may visit the site while engaged in a range of activities such as hiking, dirt-bike riding, horseback riding, snowmobiling, etc. (see Appendix D). For the purposes of this assessment, two scenarios have been selected to serve as representative activities for a recreational visitor at the site:

> *Hiker:* The hiker is selected to represent a typical exposure at the site. The hiker population is assumed to include older children, adolescents, or adults who passes across the site while hiking in the area.
>
> *ATV Rider:* ATV riders are selected because ATV riding is likely to result in higher than average exposures to on-site soils, both by incidental ingestion of surface soil and also by inhalation of dust particles that are released from soil into air by the riding activity.

For the Drainage Area, the receptors most likely to be exposed are residents from nearby communities who may visit the surface streams for recreational uses such as fishing and wading. Three populations are selected for evaluation, as described below.

> *Recreational Fisherman:* The recreational fisherman population represents individuals who may fish along streams flowing from the site.

Recreational Child Visitor: Children living in the general area of the site may visit the surface streams flowing from the site for play. This population is assumed to be comprised mainly of older children/adolescents (ages 6-12 years old).

Campers: Although camping at the mine site itself is not considered likely, camping along Elk Creek in the drainage below the site is thought to be a reasonable current or future land use. It is assumed that people who camp in the area are mainly adults and older children, and that young children (less than age 6) are unlikely to participate in this activity on a regular basis.

3.1.2 Exposure Pathways of Chief Concern

Not all of the potential exposure routes to these populations of receptors are likely to be of equal concern. First, in order to be of concern, an exposure pathway must be "complete". That is, there must be contact between a human receptor and a contaminated environmental medium. Exposure pathways that are not complete are indicated in Figure 3-1 by open boxes. For pathways that are complete, the relative importance of one to another is related to the amount of chemical taken into the body by each pathway. Exposure scenarios that are likely to result in the highest level of exposure are shown in Figure 3-1 by boxes containing a solid circle. Greatest attention is focused on quantification of exposure from these pathways in order to determine if the pathway contributes significant risk. Open circles indicate exposure paths that are likely to be complete and which might be of potential concern, but for which current methods and data are not sufficient to derive meaningful risk estimates. Pathways that are complete but which are judged to contribute only minor exposures are shown by boxes with an "X". The following sections present a more detailed description of these pathways and an analysis of their relative importance for human exposure.

Incidental Ingestion of Surface Soil

Even though few people intentionally ingest soil, recreational visitors who have direct contact with soil might ingest small amounts that adhere to their hands during outdoor activities. Because soils at mining sites are often relatively highly contaminated with metals, incidental ingestion of soil may be an important route of human exposure. Therefore, this pathway is evaluated for all receptors at the mine site.

In the drainage below the site, it is expected that any soil or mine waste contamination that has eroded from the site will be confined primarily to the sediments in Elk Creek, and that bank soils will be largely un-impacted. Therefore, ingestion of bank soils by a camper in the drainage is considered to be a minor pathway, and is not evaluated quantitatively.

Inhalation of Airborne Soil Particulates

Whenever contaminated soil is exposed at the surface, particles of contaminated surface soil may become suspended in air by wind or mechanical disturbance, and humans in the area could inhale those particles. Data on wind speed and levels of particulates in air are not available at the mine site, so screening level calculations using EPA default parameters were performed to evaluate the likely significance of this pathway (see Appendix B). Although such screening calculations are uncertain because they can not account for many site-specific factors that influence actual release of soil particles into air, the calculations are nevertheless adequate to conclude that inhalation of wind-eroded particles is likely to be minor compared to presumptive oral exposure. Therefore, this pathway is not evaluated quantitatively in this assessment. However, mechanical disturbances such as ATV riding might release much higher levels of particulates into air which may be inhaled by the ATV riders, so this pathway is evaluated quantitatively for the ATV rider.

Ingestion of Surface Water and Sediment

With the possible exception of campers along site drainages, it is not expected that most visitors to the site and the drainage area will intentionally ingest surface water. However, campers may ingest water from the creek as drinking water, and incidental ingestion of water and/or sediment might occur during other types of recreational activities (wading, playing along the creek, etc.). Based on this, oral exposure to these media were evaluated for all receptors except the ATV rider.

Dermal Contact with Soil and Sediment

All receptors may have dermal exposure to contaminated soil and/or sediment. Even though information is limited on the rate and extent of dermal absorption of metals in soil across the skin, most scientists consider that this pathway is likely to be minor in comparison to the amount of exposure that occurs by the oral route. This view is based on the recognition that most metals tend to bind to soils, reducing the likelihood that they would dissociate from the soil and cross the skin, and ionic species such as metals have a relatively low tendency to cross the skin even when contact does occur. For example, studies by Lowney (2005) have shown that dermal absorption of arsenic from Colorado and New York soils was negligible. Due to the lack of evidence supporting dermal absorption of lead from soil, neither EPA's IEUBK model or Adult Lead Model even include a dermal exposure pathway. Based on this, and recognizing that current methods and data are very limited for attempting to quantify dermal absorption of chemicals from soil, dermal contact with soil and sediment is not evaluated quantitatively in this risk assessment, but is identified as a potential source of uncertainty.

Dermal Contact with Surface Water

Recreational visitors along Elk Creek or Coal Creek may have occasional dermal contact with surface water while fishing or playing along the streams. Similar to dermal contact with soils or sediments (discussed above), uptake of metals across the skin from contact with water is usually thought to be a minor exposure pathway due to the relatively low tendency of metals to cross the skin even when contact does occur. For this reason, this pathways is not evaluated in this assessment. However, exclusion of this pathway is identified as a source of potential uncertainty.

Ingestion of Fish

Fish that live in contaminated streams may take up the contaminants from surface water, sediment or the diet, leading to exposure of humans who eat fish caught from the contaminated waters. Thus, this pathway is evaluated quantitatively in the risk assessment, both for the adult fisherman, and for a child who is part of the family of the fisherman.

3.2 Selection of Chemicals of Potential Concern

Chemicals of Potential Concern (COPCs) are chemicals which exist in the environment at concentration levels that might be of potential health concern to humans and which are or might be derived, at least in part, from site-related sources.

The procedure used to identify COPCs for the evaluation of risks to human receptors from potentially contaminated environmental media (soil, surface water, sediment, and fish tissue) at this site is shown in Figure 3-2. It is important to note that this COPC selection procedure is intended to be conservative; that is, it is expected that some chemicals may be identified as COPCs that are actually of little or no concern, but that no chemicals of authentic concern will be overlooked.

In brief, the COPC selection procedure is based on comparing the maximum detected concentration for each analyte in each medium to a Risk-Based Concentration (RBC), derived as detailed in Appendix C. For each medium in each exposure location, the RBC is based on an evaluation of exposure of the most highly exposed receptor group. If the maximum detected concentration does not exceed the RBC, it may be concluded that the chemical does not pose a significant risk to humans, including the maximally exposed individuals. If a chemical does not have an RBC, this is identified as a source of uncertainty unless the chemical is a beneficial nutrient and the expected intake from the site is within the range that is considered healthful.

The application of this COPC selection process to the data available from the site is presented in Tables 3-1 to 3-6. The results are summarized below:

Area	Medium	COPC
On-facility Area	Soil	Aluminum, Arsenic, Cadmium, Chromium, Iron, Lead, Manganese
	Surface water	None
	Sediment	None
Site Drainages	Surface water	Arsenic, Cadmium
	Sediment	Arsenic
	Fish	Arsenic

As seen, for on-site visitors, the exposure pathways that require assessment include exposures to soil (multiple COPCs, including lead) and sediment (arsenic only). For off-site recreational visitors along the site drainages, exposure pathways of potential concern include ingestion of surface water (arsenic, cadmium), sediment (arsenic) and fish (arsenic). Section 4 provides an evaluation of exposure and risks from these exposure scenarios for all COPCs except lead, and Section 5 provides an assessment of exposure and risks from lead. All other chemicals and all other exposure scenarios pose risks that are sufficiently small that they are not of concern.

4.0 EVALUATING HUMAN EXPOSURE AND RISK FROM NON-LEAD COPCs

4.1 Quantification of Exposure

4.1.1 Basic Equation

The amount of chemical which is ingested or inhaled by recreational visitors exposed to on-site soils may be quantified using the following general equation:

$$DI = C \cdot (IR / BW) \cdot (EF \cdot ED / AT) \cdot RBA$$

where:

DI = Daily intake of chemical (mg per kg of body weight per day).

C = Concentration of the chemical in the contaminated environmental medium (soil, air) to which the person is exposed. The units are mg/kg for soil and mg/m^3 for air.

IR = Intake rate of the contaminated environmental medium. The units are kg/day for soil and m^3/day for air.

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

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

ED = Exposure duration (years). This describes how long a person is likely to be exposed to the contaminated medium during their lifetime.

AT = Averaging time (days). This term specifies the length of time over which the average dose is calculated. For a chemical which causes non-cancer effects, the averaging time is equal to the exposure duration. For a chemical that causes cancer effects, the averaging time is 70 years.

RBA = Relative bioavailability

Note that the factors EF, ED, and AT combine to yield a factor between zero and one. Values near 1.0 indicate that exposure is nearly continuous over the specified averaging period, while values near zero indicate that exposure occurs only rarely.

For mathematical convenience, the general equation for calculating dose can be written as:

$$DI = C \cdot HIF \cdot RBA$$

where:

HIF = Human Intake Factor. This term describes the average amount of an environmental medium contacted by the exposed person each day. The value of HIF is typically given by:

$$HIF = (IR / BW) \cdot (EF \cdot ED / AT)$$

The units of HIF are kg/kg-day for soil and m^3/kg-day for air.

Because exposure parameters (e.g., intake rates, body weight, exposure frequency) may change as a function of age, exposure calculations are performed separately for children and adults.

4.1.2 Human Exposure Parameters

For every exposure pathway of potential concern, it is expected that there will be differences between different individuals in the level of exposure at a specific location due to differences in intake rates, body weights, exposure frequencies, and exposure durations. Thus, there is normally a wide range of average daily intakes between different members of an exposed population. Because of this, all daily intake calculations must specify what part of the range of doses is being estimated. Typically, attention is focused on intakes that are "average" or are otherwise near the central portion of the range, and on intakes that are near the upper end of the range (e.g., the 95th percentile). These two exposure estimates are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME), respectively.

Tables 4-1 to 4-6 list the CTE and RME exposure parameters and resultant HIF values used in this assessment for on-site and drainage recreational populations. Some of the values are based on USEPA default guidelines, and others are based on professional judgment or are estimated by extrapolation from other sites. Data on the frequency and duration of site visits are derived from a site-specific community interview conducted by EPA on July 27, 2006. Appendix D provides the detailed responses from these interviews, and the results for frequency and duration of visits to the site are summarized below:

Parameter	Value	Survey Result
Number of site visits per year	< 5	11
	5-20	5
	> 20	1
Hours spent at site per visit	< 5	All others
	5-10	1
	> 10	1

As seen, most respondents indicated that a majority of people would visit the site less than 20 times per year. On this basis, an RME exposure frequency of 20 days per year was selected. This would correspond to four 2-day weekend trips and two 1-week visits per year. For CTE receptors, the population-weighted average duration (6 days/year) was selected.

4.1.3 Exposure Point Concentration

An exposure point (also referred to as an exposure unit or exposure area) is an area where a receptor may be exposed to one or more environmental media. In general, receptors are assumed to move about at random within an exposure area. Because recreational visitors are likely to move about the entire site at random, the entire mine site was identified as the exposure area of concern.

Because of the assumption of random exposure over an exposure area, risk from a chemical is related to the arithmetic mean concentration of that chemical averaged over the entire exposure area. Since the true arithmetic mean concentration cannot be calculated with certainty from a limited number of measurements, the USEPA recommends that the upper 95th percentile confidence limit (UCL) of the arithmetic mean at each exposure point be used when calculating exposure and risk at that location (USEPA 1992a). If the 95% UCL exceeds the highest detected concentration, the highest detected value is used instead (USEPA 1989).

The mathematical approach that is most appropriate for computing the 95% UCL of a data set depends on a number of factors, including the number of data points available, the shape of the distribution of the values, and the degree of censoring (USEPA 2002a). The USEPA has developed a software system referred to as ProUCL, that computes the UCL for a data set by several different strategies, and then identifies which UCL is recommended. Detailed results from ProUCL can be found in Appendix E, and the results are shown in Table 4-7.

Approach for Airborne Dust from ATV Riding

No data were collected at the Standard Mine on soil particulate levels in air site generated during mechanical disturbances such as ATV riding. In the absence of measured values, the concentration of contaminants in air that would occur during ATV riding was estimated using the following equation:

$$C(air) = C(soil) \cdot PEF$$

where:

C(air) = concentration of contaminant in air (mg/m^3)
C(soil) = concentration of contaminant in soil (mg/kg)
PEF = particulate emission factor (kg of soil per m^3 of air)

Appendix F presents the derivation of the PEF for ATV riding used in the risk assessment. The resulting value is 1.18E-06 kg/m^3.

Approach for Fish

As noted above, arsenic is a COPC in fish tissue. However, arsenic that accumulates in fish tissue is present mostly in a relatively non-toxic, organic form, usually as arsenobetaine (ATSDR 2000b). Numerous studies have measured the fraction of total arsenic in fish that exists as inorganic (toxic) arsenic in fish (e.g., Yost et al. 1998, Schoof et al. 1999, USEPA 2005c). Most measured values are below 10%, with a value of about 4% being typical (USEPA 2005c). For this assessment, it was assumed that inorganic arsenic was 10% of the total arsenic measured in fish tissue samples.

4.1.4 Relative Bioavailability

Relative bioavailability (RBA) is the ratio of the gastrointestinal absorption of a chemical from a site medium (e.g., soil or sediment) compared to the absorption of that chemical which occurred in the toxicity study used to derive the toxicity factors (RfD, SF) for the chemical. In general, metals in soil or sediment at mining sites exist in the form of mineral particles that are not rapidly solubilized in gastrointestinal fluids when ingested, while toxicity studies often utilize readily soluble forms of the test chemical. Thus, oral RBA values for metals in soil or sediment are often less than 1.0.

For arsenic, sufficient data are available to establish that oral RBA values in soil are generally in the 10-20% range (USEPA 2005b, Roberts et al. 2006). In order to be conservative, the RBA for arsenic in soil and sediment is set to 50%. Note that this value applies only to ingested soil or sediment, and a value of 1.0 is assumed for inhaled arsenic and arsenic in ingested fish. RBA data are much more limited or absent for other metals (except lead, discussed below), so the RBA values for all other metals except lead are set to 1.0. This is considered to be a conservative assumption.

4.2 Toxicity Assessment

4.2.1 Overview

The basic objective of a toxicity assessment is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects depends on exposure level. In addition, the toxic effects of a chemical frequently depend on the route of exposure (oral, inhalation, dermal) and the duration of exposure (subchronic, chronic, or lifetime). Thus, a full description of the toxic effects of a chemical includes a listing of what adverse health effects the chemical may cause, and how the occurrence of these effects depends upon dose, route, and duration of exposure.

The toxicity assessment process is usually divided into two parts: the first characterizes and quantifies the non-cancer effects of the chemical, while the second addresses the cancer effects of the chemical. This two-part approach is employed because there are typically major differences in the time-course of action and the shape of the dose-response curve for cancer and non-cancer effects.

Non-Cancer Effects

Essentially all chemicals can cause adverse health effects if given at a high enough dose. However, when the dose is sufficiently low, typically no adverse effect is observed. Thus, in characterizing the non-cancer effects of a chemical, the key parameter is the threshold dose at which an adverse effect first becomes evident. Doses below the threshold are considered to be safe, while doses above the threshold are likely to cause an effect.

The threshold dose is typically estimated from toxicological data (derived from studies of humans and/or animals) by finding the highest dose that does not produce an observable adverse effect, and the lowest dose which does produce an effect. These are referred to as the "No-observed-adverse-effect-level" (NOAEL) and the "Lowest-observed-adverse-effect-level" (LOAEL), respectively. The threshold is presumed to lie in the interval between the NOAEL and the LOAEL. However, in order to be conservative (health protective), non-cancer risk evaluations are not based directly on the threshold exposure level, but on a value referred to as the Reference Dose (RfD). The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

The RfD is derived from the NOAEL (or the LOAEL if a reliable NOAEL is not available) by dividing by an "uncertainty factor". If the data are from studies in humans, and if the observations are considered to be very reliable, the uncertainty factor may be as small as 1.0. However, the uncertainty factor is normally at least 10, and can be much higher if the data are limited. The effect of dividing the NOAEL or the LOAEL by an uncertainty factor is to ensure that the RfD is not higher than the threshold level for adverse effects. Thus, there is always a "margin of safety" built into an RfD, and doses equal to or less than the RfD are nearly certain to be without any risk of adverse effect. Doses higher than the RfD may carry some risk, but because of the margin of safety, a dose above the RfD does not mean that an effect will necessarily occur.

Cancer Effects

For cancer effects, the toxicity assessment process has two components. The first is a qualitative evaluation of the weight of evidence (WOE) that the chemical does or does not cause cancer in humans. Typically, this evaluation is performed by the USEPA, using the system summarized below:

WOE	Meaning	Description
A	Known human carcinogen	Sufficient evidence of cancer in humans.
B1	Probable human carcinogen	Suggestive evidence of cancer incidence in humans.
B2	Probable human carcinogen	Sufficient evidence of cancer in animals, but lack of data or insufficient data in humans.
C	Possible human carcinogen	Suggestive evidence of carcinogenicity in animals

For chemicals which are classified in Group A, B1, B2, or C, the second part of the toxicity assessment is to describe the carcinogenic potency of the chemical. This is done by quantifying how the number of cancers observed in exposed animals or humans increases as the dose increases. Typically, it is assumed that the dose response curve for cancer has no threshold, arising from the origin and increasing linearly until high doses are reached. Thus, the most convenient descriptor of cancer potency is the slope of the dose-response curve at low doses (where the slope is still linear). This is referred to as the Slope Factor (SF), which has dimensions of risk of cancer per unit dose.

Estimating the cancer Slope Factor is often complicated by the fact that observable increases in cancer incidence usually occur only at relatively high doses, frequently in the part of the dose-response curve that is no longer linear. Thus, it is necessary to use mathematical models to extrapolate from the observed high dose data to the desired (but unmeasurable) slope at low dose. In order to account for the uncertainty in this extrapolation process, USEPA typically chooses to employ the upper 95th confidence limit of the slope as the Slope Factor. That is, there is a 95 percent probability that the true cancer potency is lower than the value chosen for the Slope Factor. This approach ensures that there is a margin of safety in cancer as well as non-cancer risk estimates.

4.2.2 Human Toxicity Values

Toxicity values (RfD and SF values) that have been established by USEPA are listed in an on-line database referred to as "IRIS" (Integrated Risk Information System). Other toxicity values are available as interim recommendations from USEPA's Superfund Technical Assistance Center operated by the National Center for Environmental Assessment (NCEA). Table 4-8 summarizes the toxicity values used for evaluation of human health risks from COPCs at this site. Points to note regarding the data in this table are listed below:

- The RfD for manganese in soil is based on the oral RfD of 1.4E-01 mg/kg-day in the diet. In accord with recommendations in IRIS, this value is modified by dividing by a Modifying Factor of 3 for application to exposures from soil or water.

- The valence state of chromium in soil at this site is not known. In the COPC selection step, it was conservatively assumed that all chromium is present as the hexavalent form, since this has a lower RfD than the trivalent form and is also considered to be carcinogenic when inhaled. However, most chromium in soils tends to be in the trivalent form (ATSDR 2000c). Therefore, for actual risk calculations, it was assumed that 85% of chromium in soil exists in the trivalent form, and 15% exists in the hexavalent form.

4.3 Risk Characterization

4.3.1 Basic Approach

Non-Cancer Effects

The potential for non-cancer effects is evaluated by comparing the estimated daily intake of chemical from site-related exposures to the oral or inhalation RfD derived by USEPA. This comparison results in a non-cancer Hazard Quotient (HQ), as follows (USEPA 1989):

$$HQ = DI / RfD$$

where:

HQ = Hazard Quotient
DI = Daily Intake (mg/kg-day)
RfD = Reference Dose (mg/kg-day)

If the HQ is equal to or less than one (1E+00), it is believed that there is no appreciable risk that non-cancer health effects will occur. If an HQ exceeds 1E+00, there is some possibility that non-cancer effects may occur, although an HQ above 1E+00 does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all RfD values (see Section 4.2.1). However, the larger the HQ value, the more likely it is that an adverse effect may occur.

If an individual is exposed to more than one chemical, a screening-level estimate of the total non-cancer risk is derived simply by summing the HQ values for that individual. This total is referred to as the Hazard Index (HI). If the HI value is less than 1E+00, non-cancer risks are not expected from any chemical, alone or in combination with others. If the screening level HI exceeds 1E+00, it may be appropriate to perform a follow-on evaluation in which HQ values are added only if they affect the same target tissue or organ system (e.g., the liver). This is because chemicals which do not cause toxicity in the same tissues are not likely to cause additive effects.

Cancer Effects

The excess risk of cancer from exposure to a chemical is described in terms of the probability that an exposed individual will develop cancer because of that exposure by age 70. For each chemical of concern, this value is calculated from the daily intake of the chemical from the site, averaged over a lifetime (DI_L), and the slope factor (SF) for the chemical, as follows (USEPA 1989):

$$\text{Excess Cancer Risk} = 1 - \exp(-DI_L \cdot SF)$$

In most cases (except when the product of $DI_L \cdot SF$ is larger than about 0.01), this equation may be accurately approximated by the following:

$$\text{Excess Cancer Risk} \approx DI_L \cdot SF$$

Excess cancer risks are summed across all chemicals of concern and all exposure pathways that contribute to exposure of an individual in a given population.

The level of total cancer risk that is of concern is a matter of personal, community, and regulatory judgment. In general, the USEPA considers excess cancer risks that are below about 1E-06 to be so small as to be negligible, and risks above 1E-04 to be sufficiently large that some sort of remediation is desirable. Excess cancer risks that range between 1E-04 and 1E-06 are generally considered to be acceptable (USEPA 1991b), although this is evaluated on a case by case basis, and USEPA may determine that risks lower than 1E-04 are not sufficiently protective and warrant remedial action.

4.3.2 Risks to Recreational Visitors at On-Site Locations

Detailed calculations of exposure and risk are presented in Appendix G. The results for recreational visitors exposed at on-site locations are shown in Table 4-9. Inspection of this table reveals the following main conclusions:

- Non-cancer risks (Panel A) are below a level of concern (HI < 1) for all chemicals and all receptors, except for manganese. This chemical poses an HI above a level of concern for the RME child ATV rider (HI = 2E+00). This risk is due almost exclusively to the inhalation pathway. Figure 4-1 shows the locations of individual soil samples where the HI for manganese for the child ATV rider (the maximally at risk receptor) exceeds 1.0.
- Excess cancer risks (Panel B) do not exceed EPA's usual level of concern (1E-04) for any receptor or any chemical, alone or in combination.

The results indicate that health risk to on-site recreational visitors is likely to be below a level of concern unless site activities result in the generation of elevated levels of dust.

4.3.3 Risks to Recreational Visitors Exposed Along Site Drainages

Results for recreational visitors exposed to surface water, sediment and/or fish caught along site drainages (Elk Creek and Coal Creek) are shown in Table 4-10. Inspection of this table reveals the following main conclusions:

- Non-cancer risks are below a level of concern (HI < 1) for all receptors.
- Excess cancer risks do not exceed EPA's usual level of concern (1E-04) for any receptor.

With respect to the potential for cancer risks from arsenic in fish, two points are worth noting. First, the concentrations of arsenic measured in fish from the site (an average of about 0.6-0.9 mg/kg) are similar to levels expected in fish purchased at the store (usually about 2-7 mg/kg in seafood and about 0.05-0.5 mg/kg in freshwater fish) (USEPA 2005c, Yost et al 1998, Schoof et al 1999). Second, the concentration pattern of arsenic in fish indicates that the highest levels occur in Coal Creek upstream of Elk Creek, as shown below:

Location	Average Conc. (mg/kg ww)
Elk Creek	0.6
Coal Creek above Elk Creek	3.7
Coal Creek below Elk Creek	0.9
Splain's Gulch (Background)	0.2

These results indicate that arsenic is present in all waters in the watershed, and that levels in Elk Creek (the primary drainage from Standard Mine) are lower than in Coal Creek.

Taken together, these results indicate that health risk to people who fish, play or camp along Elk Creek or Coal Creek is likely to be below a level of concern. As noted earlier, risks from incidental ingestion of surface water and sediment along these drainages is also below a level of concern.

4.4 Uncertainty Assessment

Quantitative evaluation of the risks to humans from environmental contamination is frequently limited by uncertainty regarding a number of key data items, including concentration levels in the environment, the true level of human contact with contaminated media, and the true dose-response curves for non-cancer and cancer effects in humans. This uncertainty is usually addressed by making assumptions or estimates for uncertain parameters based on whatever limited data are available. Because of these assumptions and estimates, the results of risk calculations are themselves uncertain, and it is important for risk managers and the public to keep this in mind when interpreting the results of a risk assessment. The following sections review the main sources of uncertainty in the risk calculations performed at the Standard Mine site.

4.4.1 Uncertainties in Exposure Assessment

Uncertainties from Exposure Pathways Not Evaluated

As discussed above, humans may be exposed to site-related chemicals by a number of pathways, but not all of these pathways were evaluated quantitatively in this risk assessment. In most cases, this is because the contribution of the pathway omitted is believed to be minor compared to one or more other pathways that were evaluated. In these cases, omission of the minor pathways will result in a small underestimation of exposure and risk, but the magnitude of this underestimation is not expected to be significant. One potential exception is dermal exposure.

This pathway was not evaluated because current methods for estimating dermal uptake are too limited to support meaningful risk estimates. In general, dermal absorption of metals is expected to be minor, especially from dermal contact with soil, since the metals would likely be adsorbed to the soil particles, and transport of ionic chemicals across the skin is generally quite slow. However, because data are so limited, omission of this pathway could result in an underestimate of exposure, and this is a source of uncertainty.

Uncertainties From Chemicals Not Evaluated

As discussed above, exposure and risk were quantified only for a selected subset (the COPCs) of chemicals detected in environmental media. While omission of other chemicals might tend to underestimate total risks, this is not a significant source of uncertainty because the chemicals that were excluded are known to be present at concentrations that are well below a level of concern.

Uncertainties in Exposure Point Concentrations

In all exposure calculations, the desired input parameter is the true mean concentration of a contaminant within a medium, averaged over the area where random exposure occurs. However, because the true mean cannot be calculated based on a limited set of measurements, the USEPA (1989, 1992) recommends that the exposure estimate be based on the 95% upper confidence limit of the mean. At this site, the data for on-site soils are of sufficient quantity and quality that the 95% UCL of the mean is only moderately larger than the sample mean, so this source of uncertainty is relatively minor.

In the case of risks from dust released into air by ATV riding, no measured data were available so airborne concentrations were estimated using a screening-level soil-to-air transfer model. In general, such predicted concentration values have high uncertainty compared to measured values, so the actual concentrations of manganese and other chemicals in airborne dusts are uncertain, and true values might be either higher or lower than calculated.

Uncertainties in Human Exposure Parameters

Accurate calculation of risk values requires accurate estimates of the level of human exposure that is occurring. However, many of the required exposure parameters are not known with certainty and must be estimated from limited data or knowledge. For example, even though site-specific data were collected on the frequency and duration of exposures of recreation visitors at the site, the number of respondents was sufficiently low that actual values can only be estimated. Likewise, data are absent on the amount of actual amount of soil, sediment and surface water ingested by recreational visitors, and the values used in the calculations are based mainly on professional judgment. In general, when exposure data were limited or absent, the exposure parameters were chosen in a way that was intended to be conservative. For example, recall that a relative bioavailability of 1.0 was assumed for all chemicals, even though values less than 1.0 are likely. Because of this generally conservative approach, the values selected are thought to be more likely to overestimate than underestimate actual exposure and risk.

4.4.2 Uncertainties in Toxicity Values

Toxicity information for many chemicals is often limited. Consequently, there are varying degrees of uncertainty associated with toxicity values (i.e., cancer slope factors, reference doses). For example, uncertainties can arise from the following sources:

- Extrapolation from animal studies to humans
- Extrapolation from high dose to low dose
- Extrapolation from continuous exposure to intermittent exposure
- Limited or inconsistent toxicity studies

In general, uncertainty in toxicity factors is one of the largest sources of uncertainty in risk estimates at a site. Because of the conservative methods USEPA uses in dealing with the uncertainties, it is much more likely that the uncertainty will result in an overestimation rather than an underestimation of risk.

At this site, the primary source of risk is inhalation exposure to manganese. The toxicity value for inhaled manganese is based on observations in exposed workers, where a level of 0.15 mg/m^3 was noted to increase the frequency of neurological symptoms in the workers. Based on the screening level calculations described above, the concentration of manganese in air during ATV riding is expected to be about 0.003 mg/m^3. This suggests that risks to on-site recreational visitors is likely to be low. However, because of the possibility that some individuals may be especially sensitivity to manganese, and because of limitations in the available toxicity data, EPA applied an uncertainty factor of 1000 when deriving a reference concentration for use in evaluating risks to the general population. Therefore, the inhalation RfD used to evaluate risks from inhaled manganese should be recognized as uncertain, and is more likely to overestimate than underestimate actual risks.

4.4.3 Uncertainties in Risk Estimates

Because risk estimates for a chemical are derived by combining uncertain estimates of exposure and toxicity (see above), the risk estimates for each chemical are more uncertain than either the exposure estimate or the toxicity estimate alone. Additional uncertainty arises from the issue of how to combine risk estimates across different chemicals. In some cases, the effects caused by one chemical do not influence the effects caused by other chemicals. In other cases, the effects of one chemical may interact with effects of other chemicals, causing responses that are approximately additive, greater than additive (synergistic), or less than additive (antagonistic). In most cases, available toxicity data are not sufficient to define what type of interaction is expected, so USEPA generally assumes effects are additive for non-carcinogens that act on the same target tissue and for carcinogens (all target tissues). At this site, non-cancer risks are contributed nearly exclusive by manganese, so additivity of HQ values across different COPCs is a minor source of uncertainty. Likewise, cancer risks are contributed mainly by arsenic with negligible contributions from other chemicals (cadmium, chromium, cobalt), so interactions between these chemicals is unlikely to be a source of significant uncertainty.

5.0 EVALUATING HUMAN EXPOSURE AND RISK FROM LEAD

5.1 Overview

Use of Blood Lead as the Measure of Exposure and Risk

Risks from lead are evaluated using a somewhat different approach than for most other chemicals. First, because lead is widespread in the environment, exposure can occur by many different pathways. Thus, lead risks are usually based on consideration of total exposure (all pathways) rather than just site-related exposures. Second, because studies of lead exposures and resultant health effects in humans have traditionally been described in terms of blood lead level, lead exposures and risks are typically assessed by describing the levels of lead that may occur in the blood of exposed populations and comparing these to blood lead levels of potential health concern. For convenience, the concentration of lead in blood is usually abbreviated "PbB", and is expressed in units of ug/dL.

Blood Lead level of Concern

Concern over health effects from elevated blood lead levels is greatest for young children or the fetus of pregnant women. There are several reasons for this focus on young children or the fetus, including the following: 1) young children typically have higher exposures to lead-contaminated media per unit body weight than adults, 2) young children typically have higher lead absorption rates than adults, and 3) young children and fetuses are more susceptible to effects of lead than are adults. After a thorough review of all the data, the USEPA identified 10 ug/dL as the concentration level at which effects begin to occur that warrant avoidance, and has set as a goal that there should be no more than a 5% chance that a child will have a blood lead value above 10 ug/dL (USEPA 1991c, 1994b). Likewise, the Centers for Disease Control (CDC) has established a guideline of 10 ug/dL in preschool children which is believed to prevent or minimize lead-associated cognitive deficits (CDC 2005). For convenience, the probability of a blood lead value exceeding 10 ug/dL is referred to as P10.

Although the value of 10 ug/dL is based on studies in young children, it is generally assumed that the same value is applicable to a fetus *in utero*. Available data suggest that the ratio of the blood lead level in a fetus to that of the mother is approximately 0.9 (Goyer, 1990). Thus, the blood lead level in a pregnant female that would correspond to a blood lead level of 10 ug/dL in the fetus is:

$$\text{PbB(mother)} = 10\ \text{ug/dL} / 0.9 = 11.1\ \text{ug/dL}$$

Populations of Chief Concern at This Site

As discussed in Section 3.2, screening level calculations (see Appendix C-2) indicate that lead is not of concern to off-site visitors, but might be of concern to on-site visitors who are exposed to on-site soils including adult hikers and ATV riders, as well as older children (age 6-12) riding ATVs. Because children in this age range are not expected to become pregnant, this assessment focuses on risks to the fetus of adult women hikers or ATV riders exposed by incidental ingestion of on-site soils and/or inhalation of on-site airborne dusts.

5.2 Lead Exposure Model

The USEPA's Technical Workgroup for Lead (USEPA 2003) has identified a general method for evaluating risks from lead for older children and adults. This model, based on the work of Bowers et al. (1994), predicts the blood lead level in a person with a site-related lead exposure by summing the "baseline" blood lead level (PbB0) (that which would occur in the absence of any site-related exposures) with the increment in blood lead that is expected as a result of increased exposure due to contact with a lead-contaminated site medium. The latter is estimated by multiplying the average daily absorbed dose of lead from site-related exposure by a "biokinetic slope factor" (BKSF). Thus, the basic equation for exposure to lead in soil and air is:

$$\text{PbB} = \text{PbB0} + \text{BKSF} \cdot [\text{PbS} \cdot \text{IRs} \cdot \text{AFs} \cdot \text{EF}/365 + \text{PbS} \cdot \text{PEF} \cdot \text{IRa} \cdot \text{AFa} \cdot \text{EF}/365]$$

where:

PbB = Geometric mean blood lead concentration (ug/dL) in women of child-bearing age) that are exposed at the site

PbB0 = "Background" geometric mean blood lead concentration (ug/dL) in women of child-bearing age in the absence of exposures to the site

BKSF = Biokinetic slope factor (ug/dL blood lead increase per ug/day lead absorbed)

PbS = Average soil lead concentration (ug/g)

IR = Intake rate of soil (IRs) (g/day) or intake rate of air (IRa) (m^3/day)

AF = Absorption fraction for lead ingested in soil (AFs) or inhaled in air (AFa)

EF = Exposure frequency for onsite exposure (days per year)

Once the geometric mean blood lead value in adult women is calculated, the full distribution of likely blood lead values in the population of exposed people can then be estimated by assuming the distribution is lognormal with a specified individual geometric standard deviation (GSDi). The probability that a random member of the population will have a blood lead value exceeding 11.1 ug/dL (corresponding a value of 10 ug/dL in the fetus) can then be calculated using the basic equations for a lognormal distribution (Aitchison and Brown, 1957).

5.3 Model Inputs and Results

Input values selected for use in the adult lead model are summarized in the upper portion of Table 5-1. The average soil concentration of lead across the site is 3,600 mg/kg. This value was used in the exposure calculations. Human exposure parameters are based on the CTE values assumed for oral and inhalation exposure of recreational visitors to on-site soil (see Table 4-1). The baseline blood lead value and the individual geometric mean value are both based on analysis by AGEISS (1996) of blood lead data originally collected by Bornschein in 1994 at the Bingham Creek site, a mining site near Salt Lake City. In this study, blood lead data were obtained for 127 pregnant or nursing women. The baseline blood lead value of 1.7 ug/dL is the geometric mean blood lead concentration for these women, and the GSD_i value of 1.5 was derived from these data using the sliding box model approach recommended by USEPA (1994a). This GSD value is lower than the national default range of 1.8 to 2.1 suggested by USEPA (2003), but the data from the Bingham Creek site are used because reliable regional data from a similar site are preferred over national default statistics. Other biokinetic parameters, including an RBA of 60%, are the defaults recommended by USEPA (2003).

The results of the calculations are shown in the lower half of Table 5-1. As seen, the probability of a fetal blood lead concentration exceeding USEPA's health based level of 10 ug/dL is very low ($P10 \leq 0.001\%$) for both hikers and ATV riders, and does not approach the risk based goal ($P10 \leq 5\%$). These results indicate that levels lead in on-site soils will not likely pose a risk to on-site recreational visitors.

5.4 Uncertainty Assessment

Quantification of risks to humans from exposures to lead are subject to a number of data limitations and uncertainties. The most import of the factors at this site are summarized below.

Uncertainty in Exposure

Exposure to lead at the site occurs mainly through the ingestion pathway, with only a small additional dose being contributed by the inhalation pathway. Thus, the main source of uncertainty in lead exposure is the amount of soil ingested by on-site recreational visitors. No data are available for soil intake rates for populations of this type, and the values assumed in the calculations are based on professional judgment, using data for residential exposures as a frame of reference. Thus, actual ingested doses are uncertain and might be either higher or lower than assumed.

Uncertainty in Model Predictions

Even if the amount of lead ingested or inhaled at the site were known with confidence, the effect on blood lead would still be uncertain. This is because the rate and extent of blood lead absorption is a highly complex physiological process, and can only be approximated by a mathematical model. Thus, the blood lead values predicted by the adult lead model should be understood to be uncertain, and are more likely to be high than low. However, because the predicted values are well below the health-based values, there is relatively little uncertainty in the conclusion that lead is not a significant source of risk to on-site recreational visitors.

6.0 REFERENCES

Aitchison, J., Brown, J.A.C. 1957. The Lognormal Distribution - University of Cambridge Department of Applied Economics Monograph. Cambridge University Press.

ATSDR. 2000a. Toxicological Profile for Manganese. September 2000. ATSDR Toxicological Profiles Web Site. http://www.atsdr.cdc.gov/toxprofiles/tp2.html.

ATSDR. 2000b. Toxicological Profile for Arsenic. September, 2000. ATSDR Toxicological Profiles Web Site. http://www.atsdr.cdc.gov/toxprofiles/tp2.html.

ATSDR. 2000c. Toxicological Profile for Chromium. September 2000. ATSDR Toxicological Profiles Web Site. http://www.atsdr.cdc.gov/toxprofiles/tp2.html

Bowers, T.S., Beck, B.D., Karam, H.S. 1994. Assessing the Relationship Between Environmental Lead Concentrations and Adult Blood Lead Levels. Risk Analysis 14:183-189.

CDC. 2005. Preventing Lead Poisoning In Young Children. Centers for Disease Control and Prevention (CDC). Atlanta (GA). August, 2005.

Goyer, R.A. 1990. Transplacental Transport of Lead. Environ. Health Perspect. 89:101-105.

IRIS. 2007. Integrated Risk Information System. On-line database of toxicity data maintained by USEPA, available at http://www.epa.gov/iriswebp/iris/index.html.

Lowney Y.W. 2005. Relative Oral and Dermal Bioavailability of Arsenic from Soils, In Vivo Research and Progress Toward In Vitro Methods. California EPA Bioavailability of Lead and Arsenic Workshop sponsored by California Department of Toxic Substances Control. September 13, 2005.

Moran RE, Wentz DA. 1974. Effects of metal mine drainage on water quality in selected areas of Colorado. 1972-73. US Geological Survey. Colorado Water Resources Circular No 25.

NRC. 1989. Recommended Dietary Allowances, 10th ed. Food and Nutrition Board, National Research Council, National Academy Press, Washington, DC. p. 230-235.

Roberts SM, Munson JW, Lowney YW, and Ruby MV. 2007. Relative Oral Bioavailability of Arsenic from Contaminated Soils Measured in the Cynomolgus Monkey. Tox. Sci. 95:281-288.

Rumberg CB, Gery BAH, Butcher K. 1978. Gunnison County stream water quality study. EPA-908/3-78-001.

Schoof RA, Yost LJ, Eickhoff J, Crecelius EA, Cragin DW, Meacher DM, and Menzel DB. 1999. A market basket Survey of Inorganic Arsenic in Food. Food Chem. Toxicol. 37:839:846.

Stanek EJ, Calabrese EJ, Ramon B, and Pekow P. 1997. Soil Ingestion in Adults - Results of a Second Pilot Study. Ecotoxicology and Environmental Safety. 36: 249-257.

Stanek EJ, Calabrese EJ. 2000. Daily Soil Ingestion Estimates for Children at a Superfund Site. Risk Anal. 20:627-635.

Stantec Consulting Ltd. 2005. Coal Creek Watershed Protection Plan. April 2005.

Thomas, John A. and John T. Galey, Jr. 1982. Exploration and Geology of the Mt. Emmons Molybdenite Deposit, Gunnison County, Colorado. Economic Geology. 77: 1085-1104.

URS Operating Services (URSOS). 1999. Analytical Results Report for Expanded Site Inspection for the Ruby Mining District, South.

URS Operating Services (URSOS). 2000. Analytical Results Report for Expanded Site Inspection for the Ruby Mining District, South.

USEPA. 1989. Risk Assessment Guidance for Superfund (RAGS). Volume I. Human Health Evaluation Manual (Part A).

USEPA. 1991a. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." Washington, DC. OSWER Directive 9285.6-03.

USEPA. 1991b. Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions. Washington, DC. OSWER Directive 9355.0-30.

USEPA. 1991c. Update on OSWER Soil Lead Cleanup Guidance. Memo from Don R. Clay, Assistant Administrator, dated August 29, 1991. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response.

USEPA. 1992. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Supplemental Guidance to RAGS: Calculating the Concentration Term. Publication 9285.7-081.

USEPA. 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure. Draft.

USEPA. 1994a. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. NTIS #PB93-963510. EPA 9285.7-15-1. February, 1994.

USEPA. 1994b. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. Publication Number 9285.7-15-1. EPA/540/R-93/081.

USEPA. 1997a. Exposure Factors Handbook, Volumes I, II, and III. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/P-95/002Fa.

USEPA 1997b. Health Effects Assessment Summary Tables. FY 1997 Update. EPA-540-R-97-036. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Washington, D.C. July.

USEPA. 2000. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. EPA/540/R/99/005.

USEPA. 2002a. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December.

USEPA. 2002b. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. OSWER 9285.6-10. December.

USEPA. 2002c. Blood lead concentrations of U.S. adult females: Summary statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). U.S. Environmental Protection Agency, Technical Review Workgroup for Lead.

USEPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. Final. EPA-540-R-03-001. January.

USEPA. 2004. Risk Assessment Guidance for Superfund Volume I; Human Health Evaluation Manual (Part 3, Supplemental Guidance for Dermal Risk Assessment). Final. July.

USEPA. 2005a. USEPA Region III Risk-Based Concentration Table (last updated April 2005). Electronic data downloaded from http://www.epa.gov/reg3hwmd/risk/human/index.htm.

USEPA 2005b. Estimation of Relative Bioavailability of Arsenic in Soil and Soil-Like Materials by In Vivo and In Vitro Methods. USEPA Review Draft. March.

USEPA. 2005c. Toxicity and Exposure Concerns Related to Arsenic in Seafood: An Arsenic Literature Review for Risk Assessments. Part 1: Exposure Concerns. Draft report prepared for U.S. Environmental Protection Agency, Office of Superfund Remediation and Technical Innovation, by Syracuse Research Corporation. SRC-TR-04-048. May 2005.

Wentz DA. 1974. Effect of mine drainage on the quality of streams in Colorado, 1971-72. US Geological Survey. Colorado Water Resources Circular No 21.

Yost LJ, Schoof RA, and Aucoin R. 1998. Intake of Inorganic Arsenic in the North American Diet. Human and Ecological Risk Assessment 4:137:152.

This page intentionally left blank to facilitate double-sided printing.

Table 2-1. Summary of Available Data

Media	Study	Location	Number of Sample Locations	Number of Samples
Sediment	USEPA (1999, 2005, 2006)	Coal Creek Downstream of Elk Creek	14	27
		Elk Creek	10	22
		Elk Creek-Mine Drainage	2	2
Surface Water	Coal Creek Watershed Coalition	Coal Creek Downstream of Elk Creek	12	21
		Elk Creek	2	4
		Elk Creek-Mine Drainage	3	3
	USEPA (1999, 2005, 2006)	Coal Creek Downstream of Elk Creek	24	97
		Elk Creek	15	68
		Elk Creek-Mine Drainage	3	16
	USGS (1995 - 2005)	Coal Creek Downstream	1	1
Soil	USEPA (2006)	Standard Mine Vicinity	190	190
Fish Tissue	USEPA (2006)	Coal Creek Downstream of Elk Creek	3	13
		Elk Creek	1	3

Table 2-2. Summary Statistics for Surface Water Samples (Total Recoverable ug/L)

Location	Analyte	Count	Detection Frequency	Average	Standard Deviation	Minimum	Maximum
Mine Facility	Aluminum	18	67%	190	350	10	1500
	Antimony	15	7%	0.79	0.59	0.013	1.5
	Arsenic	18	17%	0.64	0.77	0.014	2.5
	Barium	6	50%	38	48	5	100
	Beryllium	13	8%	0.35	0.24	0.002	0.5
	Cadmium	18	78%	19	24	0.5	63
	Calcium	13	100%	19000	17000	3600	50000
	Chromium	18	11%	1.2	1.4	0.06	5
	Cobalt	4	50%	13	14	0.032	25
	Copper	18	72%	36	44	1.2	170
	Iron	18	44%	170	240	12	940
	Lead	18	94%	53	67	2.5	230
	Magnesium	13	85%	2300	1800	320	5400
	Manganese	18	83%	730	1000	1.9	3100
	Mercury	4	0%	0.1	0	0.1	0.1
	Nickel	15	53%	4.3	6.6	0.35	20
	Potassium	10	60%	1100	740	470	2500
	Selenium	15	13%	1.3	0.9	0.1	2.5
	Silver	18	17%	0.76	1.6	0.02	5
	Sodium	10	90%	2000	1300	670	5000
	Thallium	13	8%	0.34	0.37	0.002	1.4
	Vanadium	6	33%	9.2	12	0.05	25
	Zinc	18	100%	3400	4400	120	12000
Drainages (Elk Creek Downstream and Coal Creek Downstream)	Aluminum	116	72%	130	210	6.5	2100
	Antimony	99	21%	1	0.61	0.037	2.5
	Arsenic	103	72%	2.4	2.1	0.014	10
	Barium	61	52%	41	39	5.5	100
	Beryllium	93	18%	0.31	0.24	0.005	0.75
	Cadmium	102	64%	2.7	6.7	0.2	61
	Calcium	99	100%	26000	37000	6500	280000
	Chromium	103	17%	1.7	1.9	0.01	5
	Cobalt	55	40%	8.7	11	0.1	25
	Copper	102	63%	10	33	0.5	340
	Iron	116	78%	110	95	5	660
	Lead	115	54%	8.9	53	0.2	560
	Magnesium	99	82%	2100	1000	720	4800
	Manganese	115	100%	120	170	2.5	850
	Mercury	38	3%	0.1	0.03	0.01	0.2
	Nickel	85	53%	2.3	4.2	0.35	20
	Potassium	69	46%	1300	850	100	2500
	Selenium	99	10%	1.6	1.4	0.05	7.5
	Silver	101	19%	0.46	1	0.004	5
	Sodium	69	77%	3000	2100	1000	11000
	Thallium	89	19%	0.28	0.21	0.002	0.6
	Vanadium	60	32%	8.3	11	0.017	25
	Zinc	115	100%	450	820	45	5700

Non-detects were evaluated at 1/2 the detection limit.

Table 2-3. Summary Statistics for Sediment Samples (mg/kg dry weight)

Location	Analyte	Count	Detection Frequency	Average	Standard Deviation	Minimum	Maximum
Mine Facility	Aluminum	8	100%	9400	10000	2700	34000
	Antimony	8	62%	1.7	3	0.17	9
	Arsenic	8	100%	44	52	9.2	160
	Barium	3	100%	41	7.5	33	48
	Beryllium	8	100%	2.6	3.5	0.6	11
	Cadmium	8	100%	17	11	3.8	34
	Calcium	*8*	*100%*	*1700*	1300	470	4400
	Chromium	8	88%	3.2	2.3	0.25	7
	Cobalt	3	100%	8.7	3.4	5.3	12
	Copper	8	100%	400	610	14	1700
	Cyanide	2	100%	0.11	0.014	0.1	0.12
	Iron	8	100%	33000	32000	7800	82000
	Lead	8	100%	3200	2700	840	7900
	Magnesium	8	100%	1000	490	470	1800
	Manganese	8	100%	4200	3100	1400	10000
	Mercury	8	88%	0.046	0.051	0.007	0.15
	Nickel	8	100%	6	2.4	2.8	9
	Potassium	3	100%	580	42	550	620
	Selenium	8	75%	3.4	2.7	0.5	7.6
	Silver	8	88%	4.1	6.2	0.2	18
	Sodium	3	33%	20	18	10	40
	Thallium	8	62%	0.71	1.3	0.16	3.8
	Vanadium	3	100%	5.2	1.4	3.9	6.6
	Zinc	8	100%	2400	2200	490	6900
Drainages (Elk Creek Downstream and Coal Creek Downstream)	Aluminum	37	100%	10000	5600	4500	32000
	Antimony	37	43%	2.8	3.6	0.11	10
	Arsenic	37	100%	68	41	13	180
	Barium	18	100%	74	18	27	120
	Beryllium	37	95%	0.91	0.59	0.25	2
	Cadmium	37	100%	17	17	1.8	68
	Calcium	37	100%	3300	1700	1200	7100
	Chromium	37	95%	3.8	2.7	0.25	11
	Cobalt	18	100%	11	5.3	5.6	24
	Copper	37	100%	120	150	10	600
	Cyanide	7	43%	0.65	0.77	0.035	1.6
	Iron	37	100%	21000	7300	11000	45000
	Lead	37	100%	310	420	29	1700
	Magnesium	37	100%	2800	950	1300	5500
	Manganese	37	100%	3200	2300	560	10000
	Mercury	37	65%	0.073	0.052	0.01	0.17
	Nickel	37	100%	7.9	3.5	3	17
	Potassium	18	100%	750	190	470	1100
	Selenium	37	38%	2.3	1.8	0.49	5.9
	Silver	37	100%	1.6	1.1	0.17	4.5
	Sodium	18	100%	58	16	31	100
	Thallium	37	62%	1	1.1	0.12	3.6
	Vanadium	18	100%	9.4	2	4.8	13
	Zinc	37	100%	2400	2100	250	7200

Non-detects were evaluated at 1/2 the detection limit.

Table 2-4. Summary Statistics for Surface Soil Samples (mg/kg dry weight)

Location	Analyte	Count	Detection Frequency	Average	Standard Deviation	Minimum	Maximum
Mine Facility	Aluminum	190	100%	7100	3000	1000	18000
	Antimony	190	33%	2.5	4.6	0.39	29
	Arsenic	190	100%	76	110	4.6	680
	Barium	190	100%	120	75	24	580
	Beryllium	190	95%	0.84	0.82	0.018	6.1
	Cadmium	190	94%	7.3	13	0.025	110
	Calcium	190	100%	1900	1800	100	16000
	Chromium	190	100%	6.9	8.2	0.71	93
	Cobalt	190	98%	7.6	4.9	0.065	35
	Copper	190	100%	240	390	6	2700
	Iron	190	100%	33000	28000	5600	200000
	Lead	190	99%	3600	6900	0.22	64000
	Magnesium	190	100%	1500	600	120	3100
	Manganese	190	100%	2200	2000	180	12000
	Mercury	190	79%	0.067	0.049	0.01	0.33
	Nickel	190	98%	6.1	2.9	0.041	20
	Potassium	190	100%	1400	340	660	2600
	Selenium	190	50%	6.6	12	0.48	66
	Silver	190	98%	12	19	0.1	110
	Sodium	190	92%	100	130	0.42	1100
	Thallium	190	6%	0.55	0.67	0.33	6.5
	Vanadium	190	100%	13	4.8	3	31
	Zinc	190	100%	1400	2300	48	20000

Non-detects were evaluated at 1/2 the detection limit.

Table 2-5. Summary Statistics for Fish Fillet Samples (mg/kg wet weight)

Location	Analyte	Count	Detection Frequency	Average	Standard Deviation	Minimum	Maximum
Drainages (Elk Creek Downstream and Coal Creek Downstream)	Aluminum	13	100%	1.3	0.39	0.57	1.9
	Antimony	13	0%	0.0069	--	0.0055	0.0075
	Arsenic	13	100%	0.92	1.1	0.16	3.2
	Beryllium	13	0%	0.027	--	0.023	0.031
	Cadmium	13	100%	0.054	0.019	0.024	0.095
	Calcium	13	100%	1100	560	480	2300
	Chromium	13	100%	0.72	0.049	0.66	0.8
	Copper	13	100%	1.1	0.38	0.65	2
	Iron	13	92%	5.2	1.8	1.4	8.5
	Lead	13	38%	0.012	0.019	0.0022	0.069
	Magnesium	13	100%	340	14	310	370
	Manganese	13	100%	0.87	0.53	0.5	2.5
	Mercury	13	100%	0.039	0.021	0.019	0.081
	Nickel	13	100%	0.1	0.031	0.066	0.17
	Selenium	13	100%	0.66	0.073	0.49	0.76
	Silicon Dioxi	13	100%	8.9	2.4	5.6	13
	Silver	13	0%	0.0024	--	0.0022	0.0025
	Strontium	13	100%	2.4	1.1	0.94	4.6
	Thallium	13	15%	0.0045	0.0059	0.0022	0.023
	Zinc	13	100%	31	4.6	24	41

Non-detects were evaluated at 1/2 the detection limit.

-- = results are all non-detect

Table 3-1. COPC Selection for Exposure of Onsite Receptors to Soil

		DATA			COPC SELECTION STEPS				SOIL COPCs		
							Essential Nutrient Screen				
CHEMICAL	N	Detection Frequency	Max Concentration (mg/kg)	Soil RBC [1] (mg/kg)	Does compound have an RBC?	Is Max Detect > RBC?	Is Compond an Essential Nutrient?	Is Expected Dose >> RDI or DRV? [2]	Quant COPC	Source of Uncertainty	Not a COPC
Aluminum	190	100%	18,000	12,619	Yes	Yes	No	--	X		
Antimony	190	33%	29	120	Yes	No	No	--			X
Arsenic	190	100%	680	23	Yes	Yes	No	--	X		
Barium	190	100%	580	1,789	Yes	No	No	--			X
Beryllium	190	95%	6.1	50	Yes	No	No	--			X
Cadmium	190	94%	107	67	Yes	Yes	No	--	X		
Calcium	190	100%	16,100	--	No	No	Yes	No			X
Chromium	190	100%	93	10.3	Yes	Yes	No	--	X		
Cobalt	190	98%	35	43	Yes	No	No	--			X
Copper	190	100%	2,730	12,045	Yes	No	No	--			X
Iron	190	100%	195,999	90,338	Yes	Yes	No	--	X		
Lead	190	99%	63,500	35,645	Yes	Yes	No	--	X		
Magnesium	190	100%	3,060	--	No	No	Yes	No			X
Manganese	190	100%	12,200	186	Yes	Yes	No	--	X		
Mercury	190	79%	0.33	90	Yes	No	No	--			X
Nickel	190	98%	20	6,023	Yes	No	No	--			X
Potassium	190	100%	2,550	--	No	No	Yes	No			X
Selenium	190	50%	66	1,506	Yes	No	No	--			X
Silver	190	98%	106	1,506	Yes	No	No	--			X
Sodium	190	92%	1,060	--	No	No	Yes	No			X
Thallium	190	6%	6.5	21	Yes	No	No	--			X
Vanadium	190	100%	31	301	Yes	No	No	--			X
Zinc	190	100%	20,100	90,338	Yes	No	No	--			X

[1] RBC is calculated for soil based on recreational exposure, based on a target cancer risk of 1E-06 or a target noncancer Hazard Quotient of 0.1 for the maximally exposed receptor population (see Appendix C).

[2] RDI = Reference Daily Intake, DRV = Daily Reference Value. RDIs replace the term "U. S. Recommended Daily Allowances" (introduced in 1973 as a reference value for vitamins, minerals, and protein). DRVs are for nutrients for which no set of standards previously existed. Values obtained from http://www.fda.gov/fdac/special/foodlabel/dvs.html.

Table 3-2. COPC Selection for Exposure of Onsite Receptors to Sediment

CHEMICAL	N	DATA			COPC SELECTION STEPS				SEDIMENT COPCs		
							Essential Nutrient Screen				
		Detection Frequency	Max Detected Concentration (mg/kg)	Sediment RBC [1] (mg/kg)	Does compound have an RBC?	Is Max Detect > RBC?	Is Compond an Essential Nutrient?	Is Expected Dose >> RDI or DRV? [2]	Quant COPC	Source of Uncertainty	Not a COPC
Aluminum	8	100%	33900	>1,000,000	Yes	No	No	--			X
Antimony	8	63%	9.0	2,044	Yes	No	No	--			X
Arsenic	8	100%	157	159	Yes	No	No	--			X
Barium	3	100%	48	>1,000,000	Yes	No	No	--			X
Beryllium	8	100%	11	10,220	Yes	No	No	--			X
Cadmium	8	100%	34	5,110	Yes	No	No	--			X
Calcium	8	100%	4400	--	No	No	Yes	No			X
Chromium	8	88%	7.0	15,330	Yes	No	No	--			X
Cobalt	3	100%	12	102,200	Yes	No	No	--			X
Copper	8	100%	1720	204,400	Yes	No	No	--			X
Cyanide	2	100%	0.12	102,200	Yes	No	No	--			X
Iron	8	100%	82300	>1,000,000	Yes	No	No	--			X
Lead	8	100%	7880	405,838	Yes	No	No	--			X
Magnesium	8	100%	1830	--	No	No	Yes	No			X
Manganese	8	100%	10400	238,467	Yes	No	No	--			X
Mercury	8	88%	0.150	1,533	Yes	No	No	--			X
Nickel	8	100%	9.0	102,200	Yes	No	No	--			X
Potassium	3	100%	624	--	No	No	Yes	No			X
Selenium	8	75%	7.6	25,550	Yes	No	No	--			X
Silver	8	88%	18	25,550	Yes	No	No	--			X
Sodium	3	33%	40	--	No	No	Yes	No			X
Thallium	8	63%	3.8	358	Yes	No	No	--			X
Vanadium	3	100%	7	5,110	Yes	No	No	--			X
Zinc	8	100%	6890	>1,000,000	Yes	No	No	--			X

[1] RBC is calculated for sediment based on recreational exposure, based on a target cancer risk of 1E-06 or a target noncancer Hazard Quotient of 0.1 for the maximally exposed receptor population (see Appendix C).

[2] RDI = Reference Daily Intake, DRV = Daily Reference Value. RDIs replace the term "U. S. Recommended Daily Allowances" (introduced in 1973 as a reference value for vitamins, minerals, and protein). DRVs are for nutrients for which no set of standards previously existed. Values obtained from http://www.fda.gov/fdac/special/foodlabel/dvs.html

Table 3-3. COPC Selection for Exposure of Onsite Receptors to Surface Water

CHEMICAL	N	DATA (Total Recoverable)			COPC SELECTION STEPS				SURFACE WATER COPCs		
							Essential Nutrient Screen				
		Detection Frequency	Max Detected Concentration (ug/L)	Surface Water RBC [1] (ug/L)	Does compound have an RBC?	Is Max Detect > RBC?	Is Compond an Essential Nutrient?	Is Expected Dose >> RDI or DRV? [2]	Quant COPC	Source of Uncertainty	Not a COPC
Aluminum	18	67%	1500	2,838,889	Yes	No	No				X
Antimony	15	7%	1.50	1,136	Yes	No	No	--			X
Arsenic	18	17%	2.5	44	Yes	No	No	--			X
Barium	6	50%	100	567,778	Yes	No	No	--			X
Beryllium	13	8%	0.50	5,678	Yes	No	No	--			X
Cadmium	18	78%	63	1,419	Yes	No	No	--			X
Calcium	13	100%	50000	--	No	No	Yes	No			X
Chromium	18	11%	5.0	8,517	Yes	No	No	--			X
Cobalt	4	50%	25	56,778	Yes	No	No	--			X
Copper	18	72%	170	113,556	Yes	No	No	--			X
Iron	18	44%	936	851,667	Yes	No	No	--			X
Lead	18	94%	230	1,217,515	Yes	No	No	--			X
Magnesium	13	85%	5400	--	No	No	Yes	No			X
Manganese	18	83%	3100	56,778	Yes	No	No	--			X
Mercury	4	0%	0.10	851.67	Yes	No	No	--			X
Nickel	15	53%	20.0	56,778	Yes	No	No	--			X
Potassium	10	60%	2500	--	No	No	Yes	No			X
Selenium	15	13%	2.5	14,194	Yes	No	No	--			X
Silver	18	17%	5	14,194	Yes	No	No	--			X
Sodium	10	90%	5000	--	No	No	Yes	No			X
Thallium	13	8%	1	198.7	Yes	No	No	--			X
Vanadium	6	33%	25	2,839	Yes	No	No	--			X
Zinc	18	100%	12000	851,667	Yes	No	No	--			X

[1] RBC is calculated for surface water based on recreational exposure, based on a target cancer risk of 1E-06 or a target noncancer Hazard Quotient of 0.1 for the maximally exposed receptor population (see Appendix C).

[2] RDI = Reference Daily Intake, DRV = Daily Reference Value. RDIs replace the term "U. S. Recommended Daily Allowances" (introduced in 1973 as a reference value for vitamins, minerals, and protein). DRVs are for nutrients for which no set of standards previously existed. Values obtained from http://www.fda.gov/fdac/special/foodlabel/dvs.html.

Table 3-4. COPC Selection for Exposure of Drainage Receptors to Sediment

CHEMICAL	N	DATA			COPC SELECTION STEPS				SEDIMENT COPCs		
							Essential Nutrient Screen				
		Detection Frequency	Max Detected Concentration (mg/kg)	Sediment RBC [1] (mg/kg)	Does compound have an RBC?	Is Max Detect > RBC?	Is Compond an Essential Nutrient?	Is Expected Dose >> RDI or DRV? [2]	Quant COPC	Source of Uncertainty	Not a COPC
Aluminum	37	100%	31600	>1,000,000	Yes	No	No	--			X
Antimony	37	43%	10.2	482	Yes	No	No	--			X
Arsenic	37	100%	178	159	Yes	Yes	No	--	X		
Barium	18	100%	117	240,900	Yes	No	No	--			X
Beryllium	37	95%	2.0	2,409	Yes	No	No	--			X
Cadmium	37	100%	68	1,205	Yes	No	No	--			X
Calcium	37	100%	7110	--	No	No	Yes	No			X
Chromium	37	95%	11	3,614	Yes	No	No	--			X
Cobalt	18	100%	24	24,090	Yes	No	No	--			X
Copper	37	100%	598	48,180	Yes	No	No	--			X
Cyanide	7	43%	1.6	24,090	Yes	No	No	--			X
Iron	37	100%	45400	361,350	Yes	No	No	--			X
Lead	37	100%	1670	405,838	Yes	No	No	--			X
Magnesium	37	100%	5520	--	No	No	Yes	No			X
Manganese	37	100%	9510	56,210	Yes	No	No	--			X
Mercury	37	65%	0.17	361	Yes	No	No	--			X
Nickel	37	100%	17	24,090	Yes	No	No	--			X
Potassium	18	100%	1130	--	No	No	Yes	No			X
Selenium	37	38%	5.9	6,023	Yes	No	No	--			X
Silver	37	100%	4.50	6,023	Yes	No	No	--			X
Sodium	18	100%	97	--	No	No	Yes	No			X
Thallium	37	62%	3.6	84	Yes	No	No	--			X
Vanadium	18	100%	13	1,205	Yes	No	No	--			X
Zinc	37	100%	7180	361,350	Yes	No	No	--			X

[1] RBC is calculated for sediment based on recreational exposure, based on a target cancer risk of 1E-06 or a target noncancer Hazard Quotient of 0.1 for the maximally exposed receptor population (see Appendix C).

[2] RDI = Reference Daily Intake, DRV = Daily Reference Value. RDIs replace the term "U. S. Recommended Daily Allowances" (introduced in 1973 as a reference value for vitamins, minerals, and protein). DRVs are for nutrients for which no set of standards previously existed. Values obtained from http://www.fda.gov/fdac/special/foodlabel/dvs.html.

Table 3-5. COPC Selection for Exposure of Drainage Receptors to Surface Water

		DATA (Total Recoverable)			COPC SELECTION STEPS				SURFACE WATER COPCs		
							Essential Nutrient Screen				
CHEMICAL	N	Detection Frequency	Max Detected Concentration (ug/L)	Surface Water RBC [1] (ug/L)	Does compound have an RBC?	Is Max Detect > RBC?	Is Compond an Essential Nutrient?	Is Expected Dose >> RDI or DRV? [2]	Quant COPC	Source of Uncertainty	Not a COPC
Aluminum	116	72%	2100	60,225	Yes	No	No	--			X
Antimony	99	21%	2.50	24	Yes	No	No	--			X
Arsenic	103	72%	10	1.0	Yes	Yes	No	--	X		
Barium	61	52%	100	12,045	Yes	No	No	--			X
Beryllium	93	18%	0.75	120	Yes	No	No	--			X
Cadmium	102	64%	61	30	Yes	Yes	No	--	X		
Calcium	99	100%	280000	--	No	No	Yes	No			X
Chromium	103	17%	5.0	181	Yes	No	No	--			X
Cobalt	55	40%	25	1,205	Yes	No	No	--			X
Copper	102	63%	335	2,409	Yes	No	No	--			X
Cyanide	8	0%	0.55	56,778	Yes	No	No	--			X
Iron	116	78%	660	851,667	Yes	No	No	--			X
Lead	115	54%	563	1,217,515	Yes	No	No	--			X
Magnesium	99	82%	4790	56,778	Yes	No	Yes	No			X
Manganese	115	98%	850	56,778	Yes	No	No	--			X
Mercury	38	3%	0.20	852	Yes	No	No	--			X
Nickel	85	53%	20	56,778	Yes	No	No	--			X
Potassium	69	46%	2500	283,889	Yes	No	Yes	No			X
Selenium	99	10%	7.5	14,194	Yes	No	No	--			X
Silver	101	19%	5.0	14,194	Yes	No	No	--			X
Sodium	69	77%	11000	14,194	Yes	No	Yes	No			X
Thallium	89	19%	0.60	199	Yes	No	No	--			X
Vanadium	60	32%	25	2,839	Yes	No	No	--			X
Zinc	115	100%	5700	851,667	Yes	No	No	--			X

[1] RBC is calculated for surface water based on recreational exposure, based on a target cancer risk of 1E-06 or a target noncancer Hazard Quotient of 0.1 for the maximally exposed receptor population (see Appendix C).

[2] RDI = Reference Daily Intake, DRV = Daily Reference Value. RDIs replace the term "U. S. Recommended Daily Allowances" (introduced in 1973 as a reference value for vitamins, minerals, and protein). DRVs are for nutrients for which no set of standards previously existed. Values obtained from http://www.fda.gov/fdac/special/foodlabel/dvs.html.

Table 3-6. COPC Selection for Exposure of Drainage Receptors to Fish Tissue

CHEMICAL	N	DATA			COPC SELECTION STEPS				FISH TISSUE COPCs		
							Essential Nutrient Screen				
		Detection Frequency	Max Detected Concentration (mg/kg)	Fish Tissue RBC [1] (mg/kg)	Does compound have an RBC?	Is Max Detect > RBC?	Is Compond an Essential Nutrient?	Is Expected Dose >> RDI or DRV? [2]	Quant COPC	Source of Uncertainty	Not a COPC
Aluminum	13	100%	2	1,377	Yes	No	No	--			X
Antimony	13	0%	0.0075	0.55	Yes	No	No	--			X
Arsenic	13	100%	3.2	0.023	Yes	Yes	No	--	X		
Beryllium	13	0%	0.031	2.8	Yes	No	No	--			X
Cadmium	13	100%	0.09	1.4	Yes	No	No	--			X
Calcium	13	100%	2,290	--	No	No	Yes	No			X
Chromium	13	100%	0.80	4.1	Yes	No	No	--			X
Copper	13	100%	2.0	55	Yes	No	No	--			X
Iron	13	92%	8	413	Yes	No	No	--			X
Lead	13	38%	0.07	NC	Yes	No	No	--			X
Magnesium	13	100%	366	--	No	No	Yes	No			X
Manganese	13	100%	2.5	64	Yes	No	No	--			X
Mercury	13	100%	0.08	0.14	Yes	No	No	--			X
Nickel	13	100%	0.17	28	Yes	No	No	--			X
Selenium	13	100%	0.8	6.9	Yes	No	No	--			X
Silver	13	0%	0.0025	6.9	Yes	No	No	--			X
Thallium	13	15%	0.023	0.10	Yes	No	No	--			X
Zinc	13	100%	41	413	Yes	No	No	--			X

[1] RBC is calculated for fish based on recreational exposure, based on a target cancer risk of 1E-06 or a target noncancer Hazard Quotient of 0.1 for the maximally exposed receptor population (see Appendix C).

[2] RDI = Reference Daily Intake, DRV = Daily Reference Value. RDIs replace the term "U.S. Recommended Daily Allowances" (introduced in 1973 as a reference value for vitamins, minerals, and protein). DRVs are for nutrients for which no set of standards previously existed. Values obtained from http://www.fda.gov/fdac/special/foodlabel/dvs.html.

Table 4-1
Exposure Parameters for ATV Riders - Adult and Child at the Mine Site

Exposure Pathway	Exposure Input Parameter	Units	CTE				RME			
			Adult	Source	Child	Source	Adult	Source	Child	Source
General	Body Weight	kg	70	[1, 3]	33	[4, a]	70	[1, 3]	33	[4, a]
	Exposure Frequency	days/yr	6	[7]	6	[7]	20	[7]	20	[7]
	Exposure Duration	yr	9	[3]	2	[3]	30	[3]	6	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	2	[2]	30	[2]	6	[2]
Inhalation of Particulates	Inhalation rate	m^3/hr	2.4	[4, 6, b]	1.55	[4, 6, b]	2.4	[4, 6, b]	1.55	[4, 6, b]
	Exposure Time	hr/day	1.5	[7]	1.5	[7]	2.5	[7]	2.5	[7]
	HIF(noncancer)	$m^3/kg\text{-}d$	8.45E-04		1.16E-03		4.70E-03		6.43E-03	
	HIF(cancer)	$m^3/kg\text{-}d$	1.09E-04		3.31E-05		2.01E-03		5.52E-04	
Ingestion of Soil	Intake rate	mg/day	50	[5, c]	100	[5, c]	100	[5, c]	200	[5, c]
	Conversion factor	kg/mg	1E-06	--	1E-06	--	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	1.17E-08		4.98E-08		7.83E-08		3.32E-07	
	HIF(cancer)	kg/kg-d	1.51E-09		1.42E-09		3.35E-08		2.85E-08	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors.* OSWER Directive 9285.6-03. March.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] USEPA 1997. Exposure Factors Handbook.

[5] Professional judgment.

[6] USEPA 2001. Rocky Flats Task 3 Report.

[7] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Table 7-3, mean of male and female ages 6 - 12.

[b] Mean breathing rate for moderate and heavy activities (USEPA 1997, Table 5-23).

[c] Assumes soil ingestion is two times the soil ingestion rate of a hiker (for adult); assumes child intake is 2 times the adult rate.

Table 4-2
Exposure Parameters for Hiker - Adult at the Mine Site

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Adult	Source	Adult	Source
General	Body Weight	kg	70	[1, 3]	70	[1, 3]
	Exposure frequency	days/yr	6	[7]	20	[7]
	Exposure duration	yr	9	[3]	30	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	30	[2]
Ingestion of Soil	Ingestion rate	mg/day	25	[4, b]	50	[4, a]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	5.87E-09		3.91E-08	
	HIF(cancer)	kg/kg-d	7.55E-10		1.68E-08	
Ingestion of Sediment	Ingestion rate	mg/day	12.5	[4,b]	25	[4, c]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	2.94E-09		1.96E-08	
	HIF(cancer)	kg/kg-d	3.77E-10		8.39E-09	
Ingestion of Surface Water	Ingestion rate	mL/hour	5	[4, e]	30	[5, d]
	Exposure Time	hr/day	0.5	[4, 6]	1.5	[4, 6]
	Conversion factor	L/mL	1E-03	--	1E-03	--
	HIF(noncancer)	L/kg-d	5.87E-07		3.52E-05	
	HIF(cancer)	L/kg-d	7.55E-08		1.51E-05	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] Professional judgment.

[5] USEPA 1998. Draft Water Quality Criteria Methodology Revisions.

[6] SAF. 2000. Final. Remedial Investigation Report. Zone A. Operable Unit 3: Landfill 6. Volume 3. Appendix K. Baseline Risk Assessment May 15. (FE Warren Site).

[7] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Assumes RME soil ingestion by a recreational visitor is half of the USEPA default soil ingestion rate for a resident.

[b] Assumes CTE ingestion rate is half of the RME ingestion rate.

[c] Assumes RME sediment ingestion is same as CTE soil ingestion.

[d] 30 mL/hr is the basis for the 10 mL/day value proposed for a recreational scenario by the Draft Water Quality Criteria Methodology Revisions (USEPA 1998).

[e] Incidental ingestion from splashing or hand-to-face contact during wading assumed to be 10% of USEPA (1989) recommended default (50 ml/hr) incidentally ingested during swimming.

Table 4-3
Exposure Parameters for Recreational Fishermen - Adult in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Adult	Source	Adult	Source
General	Body Weight	kg	70	[1, 3]	70	[1, 3]
	Exposure duration	yr	9	[3]	30	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	30	[2]
Ingestion of Fish	Ingestion rate (total)	g/day	8	[4, b]	25	[4, b]
	Exposure Frequency	days/yr	234	[3]	350	[2]
	Conversion factor	kg/g	1E-03	--	1E-03	--
	Fraction from Site/Site Impacted areas	unitless	0.10	[5, c]	0.20	[5, c]
	HIF(noncancer)	kg/kg-d	7.33E-06		6.85E-05	
	HIF(cancer)	kg/kg-d	9.42E-07		2.94E-05	
Ingestion of Sediment	Ingestion rate	mg/day	12.5	[5, d]	25	[5, e]
	Exposure Frequency	days/yr	6	[6,a]	20	[6,a]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	2.94E-09		1.96E-08	
	HIF(cancer)	kg/kg-d	3.77E-10		8.39E-09	
Ingestion of Surface Water	Ingestion rate	mL/hour	5	[5, g]	30	[7, f]
	Exposure Frequency	days/yr	6	[6,a]	20	[6,a]
	Exposure Time	hr/day	0.5	[5, 8]	1.5	[5, 8]
	Conversion factor	L/mL	1E-03	--	1E-03	--
	HIF(noncancer)	L/kg-d	5.87E-07		3.52E-05	
	HIF(cancer)	L/kg-d	7.55E-08		1.51E-05	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] USEPA 1997. Exposure Factors Handbook.

[5] Professional judgment.

[6] Community interviews for determining use at the Standard Mine Site. July 2006.

[7] USEPA 1998. Draft Water Quality Criteria Methodology Revisions.

[8] SAF. 2000. Final. Remedial Investigation Report. Zone A. Operable Unit 3: Landfill 6. Volume 3. Appendix K. Baseline Risk Assessment May 15. (FE Warren Site).

Notes:

[a] Assumes exposure frequency is the same as a recreational visitor.

[b] From Section 10.10.3, recommendations for recreational freshwater anglers. RME is equivalent ot 58 meals/year and CTE is equivalent to 19 meals/year (150 g/meal).

[c] assumes 10% and 20% of fish consumed annually are from the drainage areas impacted by the Standard Mine Site.

[d] Assumes CTE ingestion rate is half of the RME ingestion rate.

[e] Assumes RME sediment ingestion is same as CTE soil ingestion.

[f] 30 mL/hr is the basis for the 10 mL/day value proposed for a recreational scenario by the Draft Water Quality Criteria Methodology Revisions (USEPA 1998).

[g] Incidental ingestion from splashing or hand-to-face contact during wading assumed to be 10% of USEPA (1989) recommended default (50 ml/hr) incidentally ingested during swimming.

Table 4-4
Exposure Parameters for Recreational Visitors - Child in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Child	Source	Child	Source
General	Body Weight	kg	33	[3, a]	33	[3, a]
	Exposure duration	yr	2	[2]	6	[2]
	Averaging Time, Cancer	yr	70	[1]	70	[1]
	Averaging Time, Noncancer	yr	2	[1]	6	[1]
Ingestion of Fish	Ingestion rate (total)	g/day	4.0	[g]	12.5	[g]
	Exposure Frequency	days/yr	234	[2]	350	[1]
	Conversion factor	kg/g	1E-03	--	1E-03	--
	Fraction from Site/Site Impacted areas	unitless	0.10	[4, c]	0.20	[4, c]
	HIF(noncancer)	kg/kg-d	7.77E-06		7.26E-05	
	HIF(cancer)	kg/kg-d	2.22E-07		6.23E-06	
Ingestion of Sediment	Ingestion rate	mg/day	25	[4, b]	50	[4, c]
	Exposure Frequency	days/yr	6	[5, d]	20	[5, d]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	1.25E-08		8.30E-08	
	HIF(cancer)	kg/kg-d	3.56E-10		7.12E-09	
Ingestion of Surface Water	Ingestion rate	mL/hour	5	[4, f]	30	[6, e]
	Exposure Frequency	days/yr	6	[5, d]	20	[5, d]
	Exposure Time	hr/day	0.5	[4, 7]	1.5	[4, 7]
	Conversion factor	L/mL	1E-03	--	1E-03	--
	HIF(noncancer)	L/kg-d	1.25E-06		7.47E-05	
	HIF(cancer)	L/kg-d	3.56E-08		6.40E-06	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[2] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.
[3] USEPA 1997. Exposure Factors Handbook.
[4] Professional judgment.
[5] Community interviews for determining use at the Standard Mine Site. July 2006
[6] USEPA 1998. Draft Water Quality Criteria Methodology Revisions.
[7] SAF. 2000. Final. Remedial Investigation Report. Zone A. Operable Unit 3: Landfill 6. Volume 3. Appendix K. Baseline Risk Assessment May 15. (FE Warren Site).

Notes:

[a] Table 7-3, mean of male and female ages 6 - 12.
[b] Assumes CTE ingestion rate is half of the RME ingestion rate.
[c] Assumes RME sediment ingestion is same as CTE soil ingestion.
[d] Assumes that exposure frequency is the same as a recreational visitor.
[e] 30 mL/hr is the basis for the 10 mL/day value proposed for a recreational scenario by the Draft Water Quality Criteria Methodology Revisions (USEPA 1998).
[f] Incidental ingestion from splashing or hand-to-face contact during wading assumed to be 10% of USEPA (1989) recommended default (50 ml/hr) incidentally ingested during swimming.

Table 4-5
Exposure Parameters for Adult Campers in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Adult	Source	Adult	Source
General	Body Weight	kg	70	[1, 3]	70	[1, 3]
	Exposure duration	yr	9	[3]	30	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	30	[2]
Ingestion of Sediment	Ingestion rate	mg/day	12.5	[4, a]	25	[4, b]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	2.94E-09		1.96E-08	
	HIF(cancer)	kg/kg-d	3.77E-10		8.39E-09	
Ingestion of Surface Water	Ingestion rate	L/day	1	[2, c]	2	[2, c]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	HIF(noncancer)	L/kg-d	2.35E-04		1.57E-03	
	HIF(cancer)	L/kg-d	3.02E-05		6.71E-04	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] Professional judgment.

[5] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Assumes CTE ingestion rate is half of the RME ingestion rate.

[b] Assumes RME sediment ingestion is same as CTE soil ingestion.

[c] Assumes water intake by camper is similar to a resident

Table 4-6
Exposure Parameters for Child Campers in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Child	Source	Child	Source
General	Body Weight	kg	33	[3, a]	33	[3, a]
	Exposure duration	yr	2	[2]	6	[2]
	Averaging Time, Cancer	yr	70	[1]	70	[1]
	Averaging Time, Noncancer	yr	2	[1]	6	[1]
Ingestion of Sediment	Ingestion rate	mg/day	25	[4, a]	50	[4, b]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	1.25E-08		8.30E-08	
	HIF(cancer)	kg/kg-d	3.56E-10		7.12E-09	
Ingestion of Surface Water	Ingestion rate	L/day	0.5	[1, c]	1	[1, c]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	HIF(noncancer)	L/kg-d	2.49E-04		1.66E-03	
	HIF(cancer)	L/kg-d	7.12E-06		1.42E-04	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[2] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[3] USEPA 1997. Exposure Factors Handbook.

[4] Professional judgment.

[5] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Assumes CTE ingestion rate is half of the RME ingestion rate.

[b] Assumes RME sediment ingestion is same as CTE soil ingestion.

[c] Assumes water intake by camper is similar to a resident

Table 4-7. Exposure Point Concentrations

Medium	COPC	Mean (mg/kg)	95% UCL (mg/kg)	Max (mg/kg)	EPC (mg/kg)
Onsite Soil	Aluminum	6,800	7,200	18,000	7,200
	Arsenic	73	120	680	120
	Cadmium	7.3	13	107	13
	Chromium	10	14	100	14
	Iron	30,000	49,000	200,000	49,000
	Lead	3,600	7,000	64,000	7,000
	Manganese	2,200	2,800	12,000	2,800
Drainage Sediment	Arsenic	68	82	180	82
Drainage Surface Water	Arsenic	2.7	4.0	10	4.0
	Cadmium	2.7	6.9	61	6.9
Drainage Fish Tissue	Arsenic	0.92	4.0	3.2	3.2

Table 4-8. Human Health Toxicity Values

CHEMICAL	NON-CANCER				CANCER					
	Oral RfD mg/kg-day	**Source**	**Inhalation RfD**	**Source**	**Inhalation SF $(mg/kg\text{-}day)^{-1}$**	**Weight of Evidence**	**Source**	**Oral SF $(mg/kg\text{-}day)^{-1}$**	**Weight of Evidence**	**Source**
Aluminum	1.0E+00	P [2]	1.0E-03	P [2]	--	--	--	--	--	--
Arsenic	3.0E-04	I	--	--	1.5E+01	A	I	1.5E+00	A	I
Cadmium-food	1.0E-03	I	5.7E-05	E [2]	6.3E+00	B1	I	--	--	--
Chromium III	1.5E+00	I	--	--	--	--	--	--	--	--
Chromium VI	3.0E-03	I	3.0E-05	I	4.1E+01	A	I	--	--	--
Iron	3.0E-01	E [1]	--	--	--	--	--	--	--	--
Manganese-food, sediment	4.7E-02	I [3]	1.4E-05	I	--	--	--	--	--	--
Manganese-water	2.0E-02	I	1.4E-05	I	--		--	--	--	--

CSF = Cancer Slope Factor
RfC = Noncancer Reference Concentration
RfD = Noncancer Reference Dose
UR = Unit Risk
NA = Not Available

Sources:
I = IRIS
E = EPA-NCEA Provisional Value
P = EPA Provisional Peer-Reviewed Value
-- = A USEPA Recommended toxicity value is not available for this chemical

Notes:
[1] As cited in Region III Tables (10/2006 update): http://www.epa.gov/reg3hwmd/risk/human/index.htm, accessed November, 2006.
[2] As cited in Region III Tables (4/2005 update).
[3] RfDo (1.4E-01 mg/kg-day) adjusted by a modifying factor of 3, in accord with IRIS and USEPA Region 8 recommendations.

Weight of Evidence:
A = Known human carcinogen
B1 = Possible human carcinogen

Table 4-9. Risks to On-Site Recreational Visitors

Panel A: Non-Cancer Risks

CTE Scenario

Chemical of	Adult ATV Rider			Child ATV Rider			Adult Hiker
Potential Concern	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion
Aluminum	9E-05	7E-03	7E-03	4E-04	1E-02	1E-02	4E-05
Arsenic	2E-03	NA	2E-03	1E-02	NA	1E-02	1E-03
Cadmium	2E-04	2E-04	4E-04	7E-04	3E-04	1E-03	8E-05
Chromium	4E-05	3E-04	4E-04	2E-04	4E-04	6E-04	2E-05
Iron	2E-03	NA	2E-03	7E-03	NA	7E-03	8E-04
Manganese	7E-04	2E-01	2E-01	3E-03	3E-01	3E-01	4E-04
Total	5E-03	2E-01	2E-01	2E-02	3E-01	3E-01	3E-03

RME Scenario

Chemical of	Adult ATV Rider			Child ATV Rider			Adult Hiker
Potential Concern	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion
Aluminum	6E-04	4E-02	4E-02	2E-03	6E-02	6E-02	3E-04
Arsenic	2E-02	NA	2E-02	7E-02	NA	7E-02	8E-03
Cadmium	1E-03	1E-03	2E-03	4E-03	2E-03	6E-03	5E-04
Chromium	2E-04	2E-03	2E-03	1E-03	2E-03	3E-03	1E-04
Iron	1E-02	NA	1E-02	5E-02	NA	5E-02	5E-03
Manganese	5E-03	1E+00	1E+00	2E-02	2E+00	2E+00	2E-03
Total	3E-02	1E+00	1E+00	1E-01	2E+00	2E+00	2E-02

Panel B: Cancer Risks

CTE Scenario

Chemical of	Adult ATV Rider			Child ATV Rider			Adult Hiker
Potential Concern	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion
Aluminum	NA	NA	NA	NA	NA	NA	NA
Arsenic	1E-07	2E-07	4E-07	1E-07	7E-08	2E-07	7E-08
Cadmium	NA	1E-08	1E-08	NA	3E-09	3E-09	NA
Chromium	NA	5E-08	5E-08	NA	2E-08	2E-08	NA
Iron	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA
Total	1E-07	3E-07	4E-07	1E-07	9E-08	2E-07	7E-08

RME Scenario

Chemical of	Adult ATV Rider			Child ATV Rider			Adult Hiker
Potential Concern	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion	Soil Inhalation	Total	Soil Ingestion
Aluminum	NA	NA	NA	NA	NA	NA	NA
Arsenic	3E-06	4E-06	8E-06	3E-06	1E-06	4E-06	2E-06
Cadmium	NA	2E-07	2E-07	NA	5E-08	5E-08	NA
Chromium	NA	9E-07	9E-07	NA	3E-07	3E-07	NA
Iron	NA	NA	NA	NA	NA	NA	NA
Manganese	NA	NA	NA	NA	NA	NA	NA
Total	3E-06	6E-06	9E-06	3E-06	2E-06	4E-06	2E-06

NA = data not available

-- = pathway not evaluated

Shaded values = level of potential concern

Table 4-10. Risks to Recreational Visitors Along Site Drainages

Panel A: Non-Cancer Risks

CTE Scenario

Chemical of Potential Concern	Adult Fisherman				Recreational Child				Adult Camper			Child Camper		
	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total
Arsenic	8E-03	4E-04	8E-06	8E-03	8E-03	2E-03	2E-05	1E-02	4E-04	3E-03	4E-03	2E-03	3E-03	5E-03
Cadmium	--	--	8E-06	8E-06	--	--	2E-05	2E-05	--	3E-03	3E-03	--	3E-03	3E-03
Total	8E-03	4E-04	8E-06	8E-03	8E-03	2E-03	2E-05	1E-02	4E-04	3E-03	4E-03	2E-03	3E-03	5E-03

RME Scenario

Chemical of Potential Concern	Adult Fisherman				Recreational Child				Adult Camper			Child Camper		
	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total
Arsenic	7E-02	3E-03	5E-04	8E-02	8E-02	1E-02	1E-03	9E-02	3E-03	2E-02	2E-02	1E-02	2E-02	3E-02
Cadmium	--	--	5E-04	5E-04	--	--	1E-03	1E-03	--	2E-02	2E-02	--	2E-02	2E-02
Total	7E-02	3E-03	5E-04	8E-02	8E-02	1E-02	1E-03	9E-02	3E-03	2E-02	2E-02	1E-02	2E-02	3E-02

Panel B: Cancer Risks

CTE Scenario

Chemical of Potential Concern	Adult Fisherman				Recreational Child				Adult Camper			Child Camper		
	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total
Arsenic	4E-06	1E-08	2E-10	4E-06	1E-07	1E-08	2E-10	1E-07	1E-08	8E-08	9E-08	1E-08	2E-08	3E-08
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	4E-06	1E-08	2E-10	4E-06	1E-07	1E-08	2E-10	1E-07	1E-08	8E-08	9E-08	1E-08	2E-08	3E-08

RME Scenario

Chemical of Potential Concern	Adult Fisherman				Recreational Child				Adult Camper			Child Camper		
	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Fish Ingestion	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total	Sediment Ingestion	Surface Water Ingestion	Total
Arsenic	1E-05	2E-07	4E-08	1E-05	3E-06	2E-07	2E-08	3E-06	2E-07	2E-06	2E-06	2E-07	4E-07	6E-07
Cadmium	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	1E-05	2E-07	4E-08	1E-05	3E-06	2E-07	2E-08	3E-06	2E-07	2E-06	2E-06	2E-07	4E-07	6E-07

NA = data not available
-- = pathway not evaluated
Shaded values = level of potential concern

Table 5-1. Evaluation of Risks from Lead

Basic Equations

PbB(fetus) = PbB(mother) * Ratio

PbB(mother) = PbB0 + BKSF*[Csoil*IRsoil*AFsoil*EF/365 + Csoil*PEF*BR*AFa*EF/365]

Data Inputs

Parameter	Units	ATV Rider	Hiker	Source	Notes
PbB0	ug/dL	1.7	1.7	AGEISS 1996	Bingham Creek Study
BKSF	ug/dL per ug/day	0.4	0.4	USEPA 2003a	USEPA default recommendation.
Ratio	ug/dL per ug/dL	0.9	0.9	USEPA 2003a	USEPA default recommendation.
GSD	--	1.5	1.5	AGEISS 1996	Bingham Creek Study
Csoil	ug/g	3600	3600	Site-specific	Mean
IRsoil	g/day	0.050	0.025	Professional judgment	CTE exposure parameter
AFsoil	--	0.12	0.12	USEPA 2003a	0.2 (default) * 0.6 (RBA)
PEF	g/m^3	1.18E-03		Appendix F	
BR	m^3/hr	2.4		USEPA 1997	Mean breathing rate for moderate and heavy activities
ET	hrs/day	1.5		Community interviews and professional judgment	
AFa	--	1.00		Professional judgment	
EF	days/year	6	6	Community interviews and professional judgment	CTE exposure parameter

Results

Absorb. Dose from soil	ug/day	0.355	0.178
Absorb. Dose from inhaled dust	ug/day	0.251	0.000
GM PbB(mother)	ug/dL	1.943	1.771
P10 (fetus)		0.001%	0.0003%

This page intentionally left blank to facilitate double-sided printing.

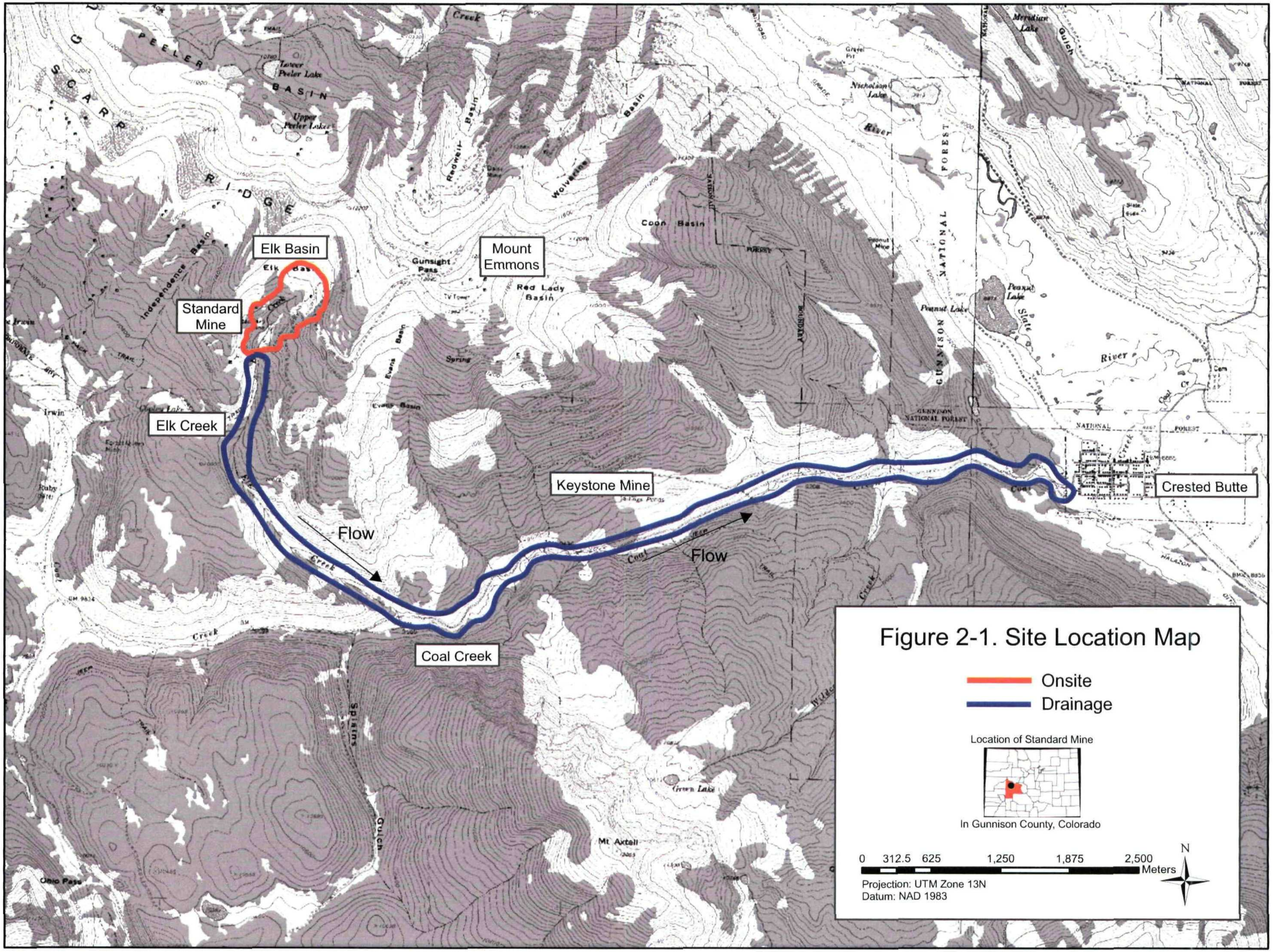


Figure 2-1. Site Location Map

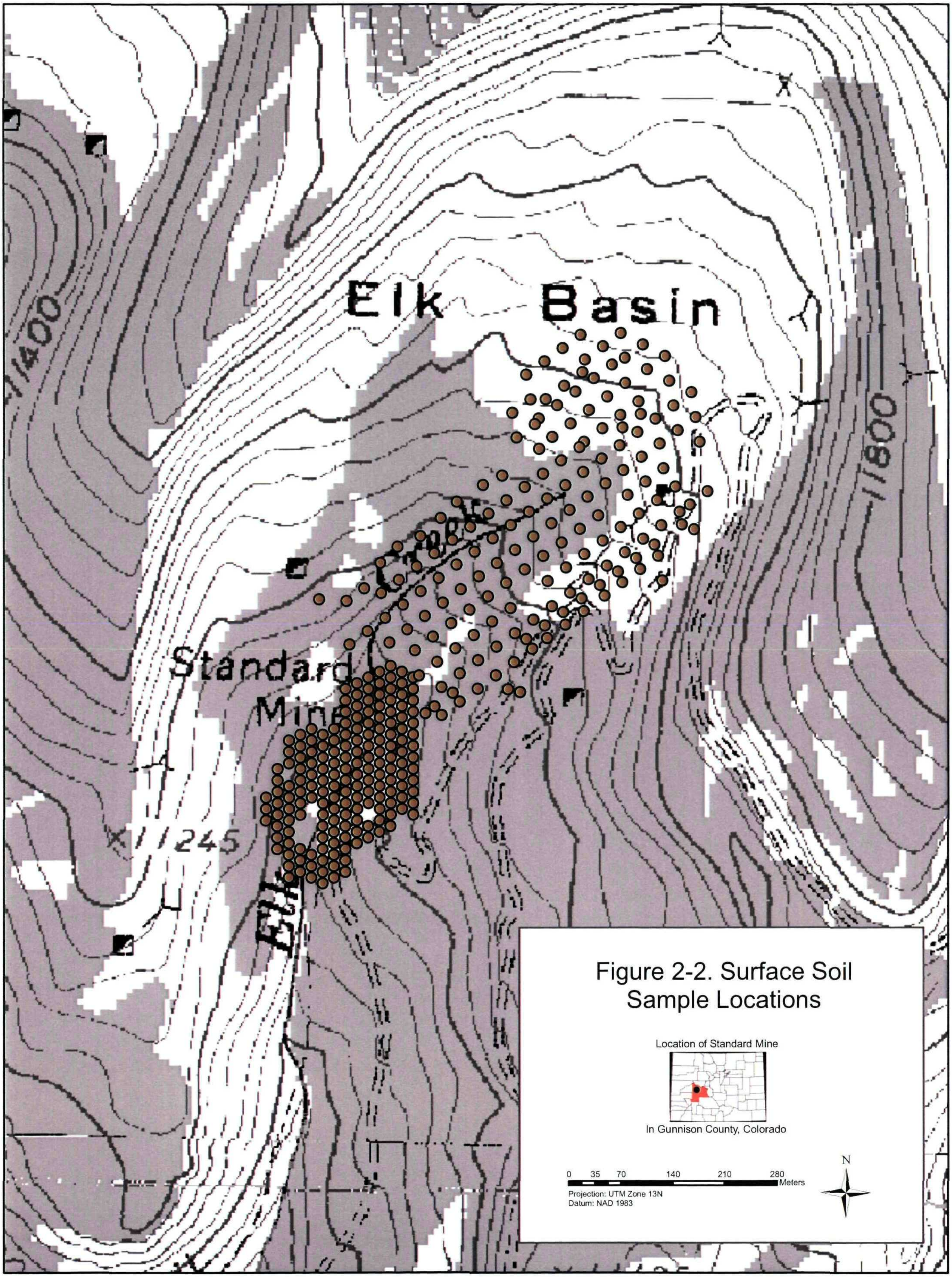


Figure 2-2. Surface Soil Sample Locations

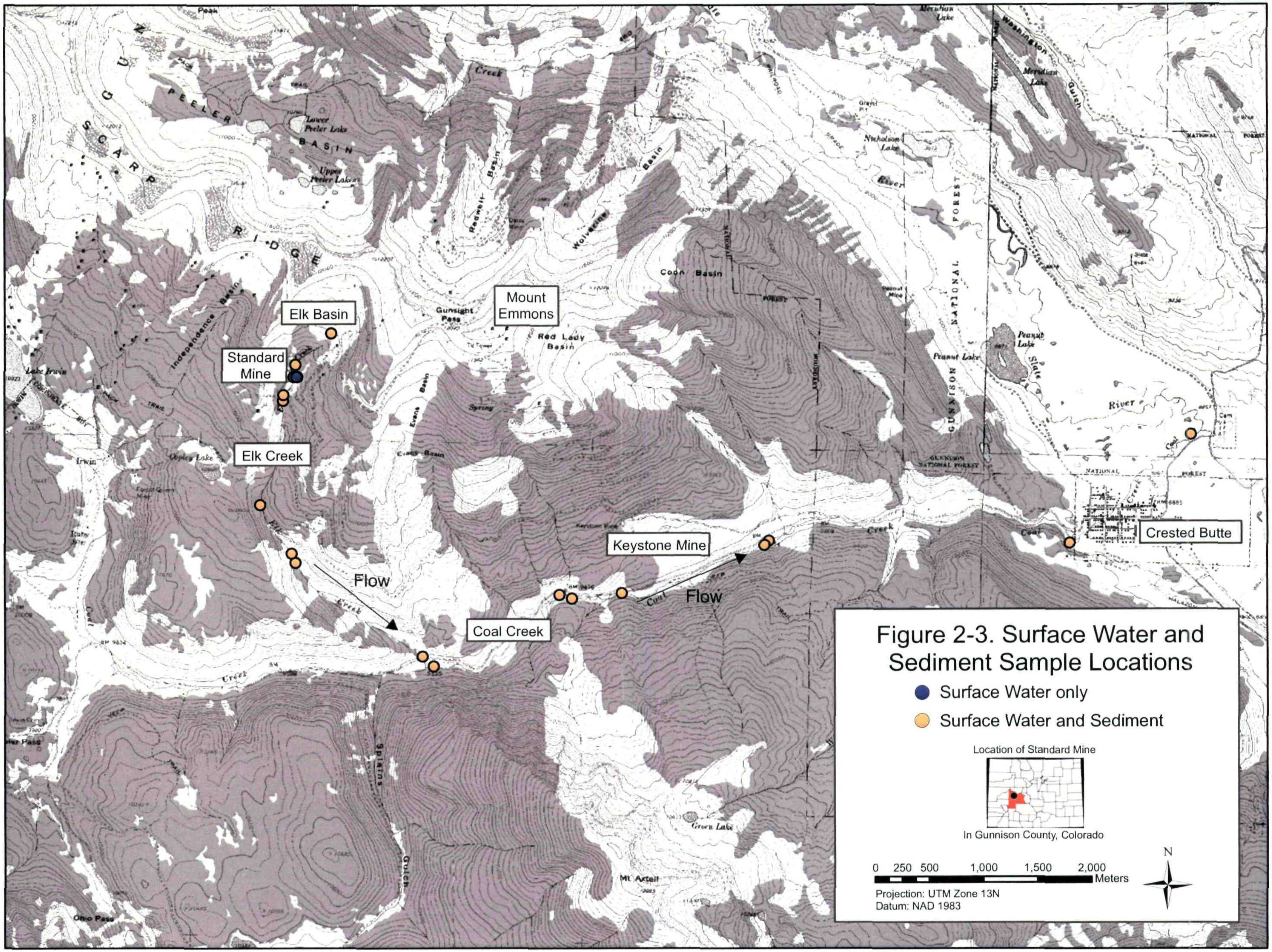


Figure 2-3. Surface Water and Sediment Sample Locations

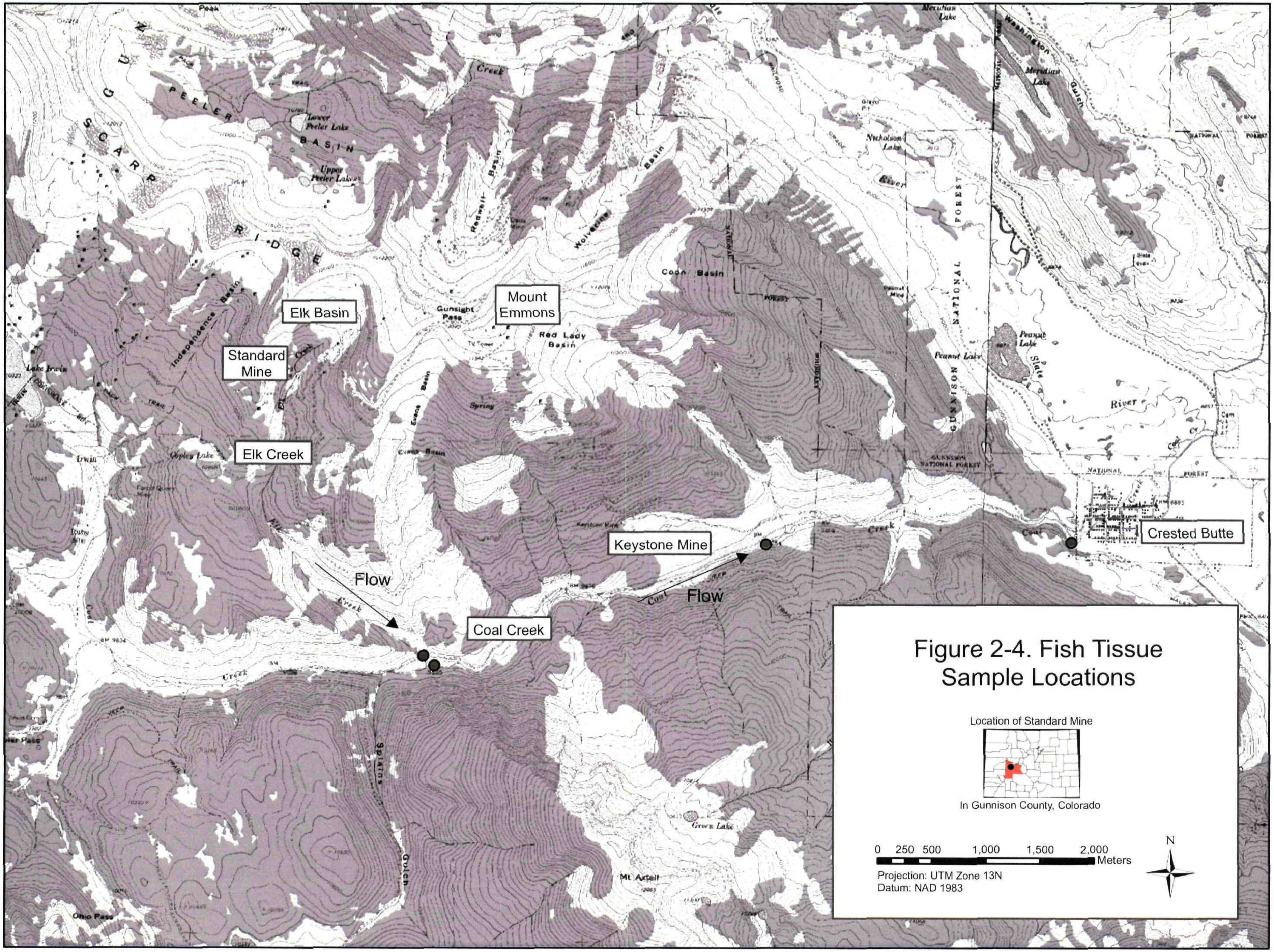
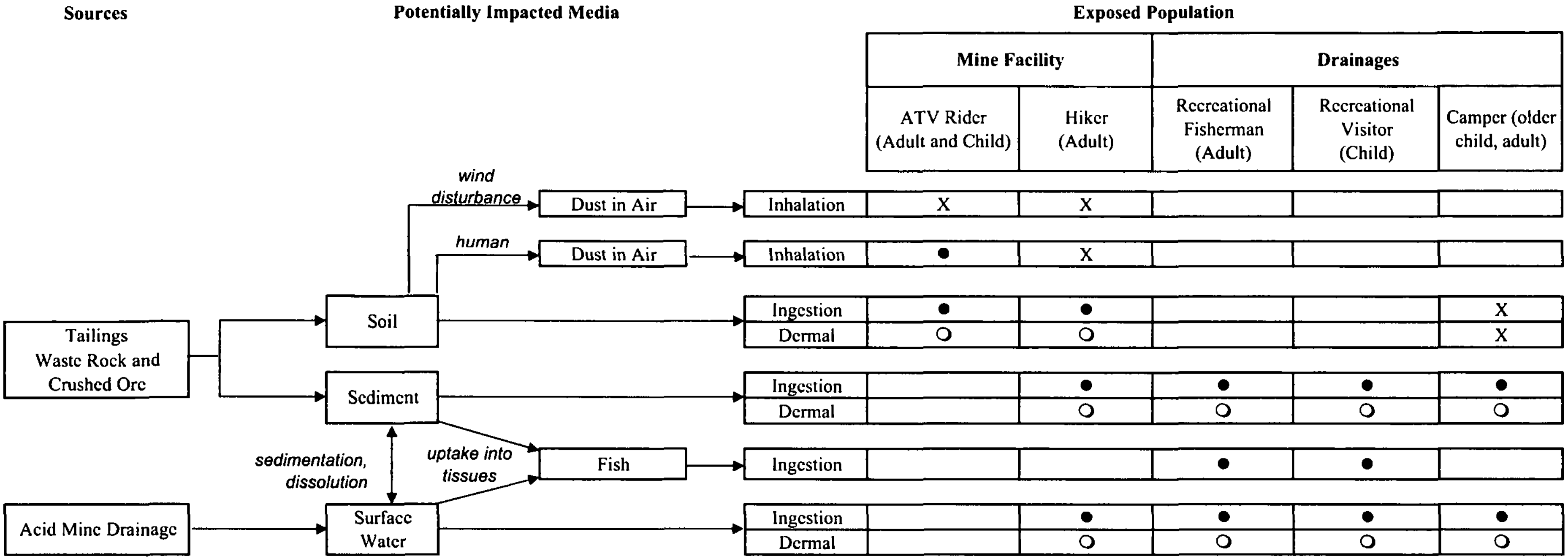


Figure 2-4. Fish Tissue Sample Locations

Figure 3-1. Site Conceptual Model for Human Exposure

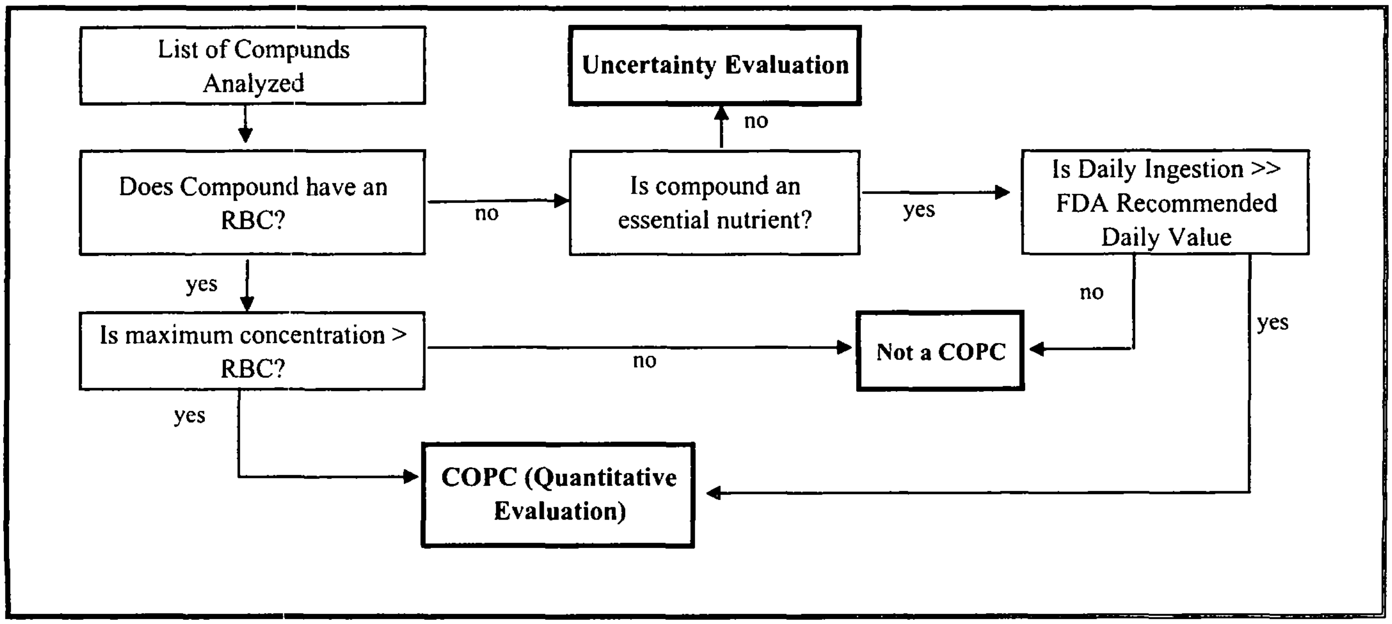


		Mine Facility		Drainages		
		ATV Rider (Adult and Child)	Hiker (Adult)	Recreational Fisherman (Adult)	Recreational Visitor (Child)	Camper (older child, adult)
Dust in Air	Inhalation	X	X			
Dust in Air	Inhalation	●	X			
Soil	Ingestion	●	●			X
	Dermal	○	○			X
Sediment	Ingestion		●	●	●	●
	Dermal		○	○	○	○
Fish	Ingestion			●	●	
Surface Water	Ingestion		●	●	●	●
	Dermal		○	○	○	○

LEGEND

●	Pathway is complete and might be significant; sufficient data are available for quantitative evaluation
○	Pathway is complete and might be significant; insufficient data are available for quantitative evaluation
X	Pathway is complete, but is judged to be minor; qualitative evaluation
	Pathway is not complete; no evaluation required

Figure 3-2. COPC Selection Procedure for Human Health



Notes:

RBC = Risk-based concentration (HQ = 0.1, Cancer risk = 1E-06)

COPC = chemical of potential concern

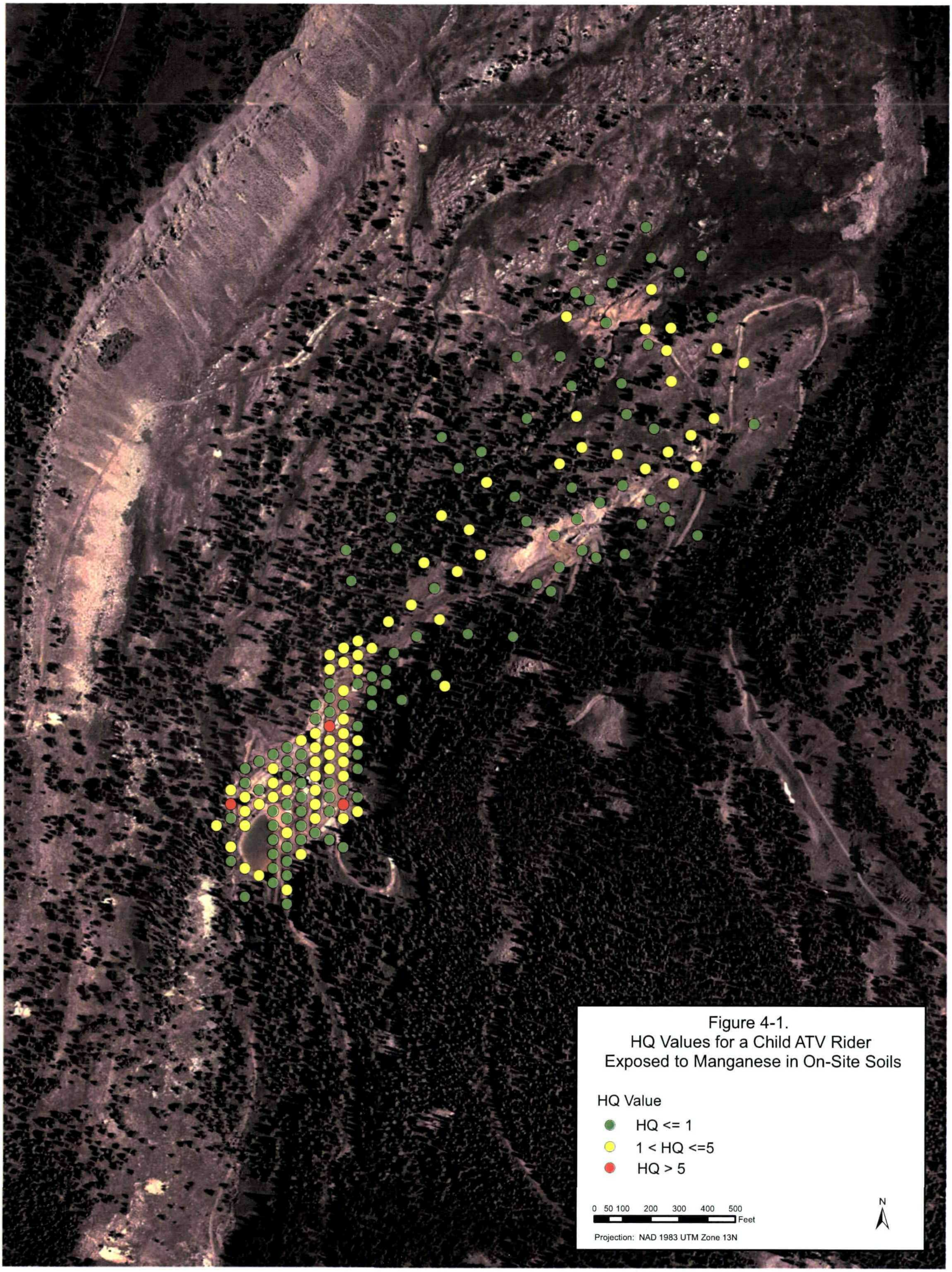


Figure 4-1.
HQ Values for a Child ATV Rider
Exposed to Manganese in On-Site Soils

Appendices

APPENDIX A

ELECTRONIC DATA

Raw data are provided electronically within the file "Standard Mine HH Raw Data.xls"

This page intentionally left blank to facilitate double-sided printing.

APPENDIX B

SCREENING LEVEL EVALUATION OF DUST INHALATION EXPOSURE PATHWAY

This page intentionally left blank to facilitate double-sided printing.

SCREENING LEVEL EVALUATION OF THE DUST INHALATION EXPOSURE PATHWAY

This appendix presents a screening level evaluation of the inhalation of particulates in air exposure pathway identified in the conceptual site model to determine if this pathway requires further evaluation the risk assessment.

Basic Approach

The screening level approach is to quantify the dose of metals inhaled from particulates in air relative to the dose of metals ingested from soil.

The basic equation recommended by EPA (1989) for evaluation of inhalation exposure is:

$$DI_{air} = C_a \cdot BR_a \cdot EF \cdot ED/(BW \cdot AT)$$

where:

DI_{air} = Daily intake from air (mg/kg-d)
C_a = Concentration of substance in air (mg/m^3)
BR_a = Breathing rate of air (m^3/day)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yrs)
BW = Body weight (kg)
AT = Averaging time (days)

and

$$C_a = PEF \cdot C_{soil}$$

where:

C_{soil} = Concentration of substance in soil (mg/kg)
PEF = Particulate Emission Factor characterizing soil to air transfer (kg/m^3)

The basic equation recommended by EPA (1989) for evaluation of soil ingestion is given by:

$$DI_{soil} = C_s \cdot IR_s \cdot EF \cdot ED/(BW \cdot AT)$$

where:

DI_{soil} = Daily intake from soil (mg/kg-d)

C_s = Concentration of substance in soil (mg/kg)
IR_s = Ingestion rate for soil (kg/day)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yrs)
BW = Body weight (kg)
AT = Averaging time (days)

Based on the above equations, the relative magnitude of the inhaled dose of a COPC from air can be compared to the ingested dose from soil as follows:

$$\text{Ratio (inhalation / ingestion)} = PEF \cdot BR_d / IR_s$$

Values for these parameters for each of the receptors identified in the conceptual model are summarized in Table B-1.

Results

Table B-1 summarizes the ratio of the mass of soil inhaled to that ingested for each of the receptors identified in the conceptual model. As seen, the inhaled dose of soil from wind erosion is very small (<<1%) compared to the ingested dose, so the wind erosion pathway is not considered significant at this site.

In contrast, the inhaled dose of airborne soil particles in association with human disturbance activities (e.g., ATV riding) may not be insignificant (>1%) compared to the ingested dose. Thus, the inhalation of particulates exposure pathway from human disturbances is evaluated quantitatively for a recreational visitor (ATV rider).

References

EPA. 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual Part A. Interim Final. Office of Solid Waste and Emergency Response (OSWER), Washington, DC. OSWER Directive 9285.701A.

TABLE B-1. PATHWAY SCREENING
INHALATION OF PARTICULATES RELATIVE TO SOIL INGESTION

Basic Equation: $DI_{air}/DI_{soil} = PEF \cdot BR_d/IR_s$

Disturbance Force	Receptor	Input Parameters			Ratio	
		PEF (kg/m^3)	BR_d (m^3/day)	IRs (kg/day)	DI_{air}/DI_{soil}	DI_{air}/DI_{soil} (%)
Wind erosion	Recreational Visitor (ATV Rider)	5.9E-09	3.6	1E-04	2E-04	0.02%
	Recreational Visitor (Hiker, adult)	5.9E-09	6.0	5E-05	7E-04	0.07%
Human activity	Recreational Visitor (ATV Rider)	1.18E-06	3.6	1E-04	4E-02	4.25%

Note: RME exposure parameters are used in the calculations

PEF = Particulate Emission Factor (see Appendix E for derivation)

BR_d = Breathing rate

IR_s = Soil Ingestion Rate

DI = Daily Intake (mg/kg-day)

This page intentionally left blank to facilitate double-sided printing.

APPENDIX C

DERIVATION OF SITE-SPECIFIC RBC VALUES FOR USE IN SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Appendix C1	**RBCs for Non-Lead Chemicals**
Appendix C2	**RBCs for Lead**

APPENDIX C1

DERIVATION OF RISK-BASED CONCENTRATIONS FOR NON-LEAD CHEMICALS

1.0 METHOD

A risk-based concentration (RBC) is the concentration level of a chemical in an environmental medium that correspond to a specified level of health risk for a specified level of human exposure. The method for computing an RBC for non-lead chemicals is to reverse the basic risk equation and solve for the concentration that corresponds to the specified risk. For non-cancer effects, the risk equation and the RBC equation are as follows:

$$HQ = C \cdot HIF_{NC} \cdot RBA / RfD$$
$$RBC_{NC} = THQ / (HIF_{NC} \cdot RBA / RfD)$$

For cancer, the equations are:

$$Risk = C \cdot HIF_{C} \cdot RBA \cdot SF$$
$$RBC_{C} = TR / (HIF_{C} \cdot RBA \cdot SF)$$

where:

HQ = Non-cancer hazard quotient for site related exposure
THQ = Target HQ for calculation of non-cancer RBC
Risk = Cancer risk from site related exposure
TR = target cancer risk for computation of cancer RBC
C = Concentration of chemical in an environmental medium
HIF_{NC} = Human intake factor for non-cancer effects
HIF_{C} = Human intake factor for cancer effects
RBA = Relative Bioavailbility
RfD = Reference dose for non-cancer effects
SF = Slope factor for cancer effects

For each receptor, the RBC for that receptor is the lower of the non-cancer and cancer RBCs:

$$RBC = \min (RBC_{NC}, RBC_{C})$$

If there is more than one receptor exposed to the site medium, the final RBC used to select chemicals of potential concern is the lowest RBC for any receptor.

2.0 INPUTS

2.1 Target Risks

The target risk values selected for use in computing RBC values are a cancer risk of 1E-06 and a non-cancer HQ of 0.1. These values are below the normal level of concern (cancer risk = 1E-04, HQ = 1.0) to account for potential additivity of risk across different chemicals and different environmental media.

2.2 HIF Values

Tables C1-1 to C1-6 list the human exposure assumptions and the resulting HIF values for each receptor considered in the Conceptual Site Model for the site. The HIF values used in computation of RBCs are based on reasonable maximum exposures (RME) for each population.

2.3 Toxicity Values

Table C1-7 lists the non-cancer and cancer toxicity values used in the computation of RBC values. These values are derived from EPA-recommended sources, as indicated. For mercury in fish, it was assumed that all of the mercury is methyl mercury. This is conservative, because some of the mercury in fish exists in the less toxic inorganic form. For cancer risk from inhalation exposure to nickel, the inhalation slope factor suggested by the California EPA was not used, since this is based on risk to workers in a nickel refinery who are exposed to nickel subsulfide and nickel carbonyl, which are not forms of nickel which occur in site soils.

2.4 RBA Values

For the purposes of the screening level COPC selection, all RBA values were assumed to be 1.0 except for arsenic in soil and sediment, where the oral RBA was assumed to be 0.5.

3.0 RESULTS

Table C1-8 is a summary of the RBC values for each analyte in each medium. As noted above, the RBC for each chemical in each exposure location is the lowest RBC for any receptor exposed to that medium. These values were used in the COPC selection procedure, as described in Section 3 of the main text. Tables C1-9 through C1-23 provide the detailed RBC calculations.

APPENDIX C1

LIST OF TABLES

APPENDIX C2

DERIVATION OF RISK-BASED CONCENTRATIONS FOR LEAD

1.0 METHOD

The USEPA (2003) recommends the following equations for computation of risk from lead to women of child-bearing age:

$$GM = PbB0 + BKSF \cdot AD$$

where:

GM = geometric mean blood lead value in an exposed individual (ug/dL)
PbB0 = baseline blood lead value (ug/dL)
BKSF = biokinetic slope factor (ug/dL in blood per ug/day absorbed)
AD = absorbed dose (ug/day)

The absorbed dose is computed as follows:

$$AD = \Sigma\,(C_i \cdot IR_i \cdot AF_i)$$

where:

C_i = Concentration of lead in medium i (ug/g in soil, ug/m^3 in air, ug/L in water)
IR_i = Average daily intake rate of medium i (g/day of soil, m^3/day of air, L/day of water)
AF_i= Absorption fraction from medium i

If exposure is not continuous, the value of IR is calculated as follows:

$$IR_i = IR_i(\text{per day}) \cdot (\text{days per year}) / 365$$

Assuming a lognormal distribution, the 95th percentile blood lead value in a group of women is given by:

$$95^{th} = GM \cdot GSD^{1.645}$$

where:

GSD = geometric standard deviation

Because the blood lead value in a fetus in slightly lower than in the blood of the mother, the 95th percentile concentration in the fetus is given by:

$$95^{th}(\text{fetus}) = 95^{th}(\text{mother})\cdot\text{Ratio}$$

where Ratio = the ratio of the concentration of blood lead in the fetus to that of the mother.

2.0 INPUTS

Human exposure parameters (intake rates and exposure frequencies) used in to the model are based on the same CTE exposure assumptions as used for other chemicals. Other values are based on USEPA(2003) or Regional default values. Table C2-1 lists the values used in the calculations.

3.0 RESULTS

Table C2-2 summarizes the RBC values for lead for exposure of adult recreational women to on-site and off-site environmental media. The detailed calculations are shown in Tables C2-3 to C2-6.

Table C1-1
Exposure Parameters for ATV Riders - Adult and Child at the Mine Site

Exposure Pathway	Exposure Input Parameter	Units	CTE				RME			
			Adult	Source	Child	Source	Adult	Source	Child	Source
General	Body Weight	kg	70	[1, 3]	33	[4, a]	70	[1, 3]	33	[4, a]
	Exposure Frequency	days/yr	6	[7]	6	[7]	20	[7]	20	[7]
	Exposure Duration	yr	9	[3]	2	[3]	30	[3]	6	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	2	[2]	30	[2]	6	[2]
Inhalation of Particulates	Inhalation rate	m^3/hr	2.4	[4, 6, b]	1.55	[4, 6, b]	2.4	[4, 6, b]	1.55	[4, 6, b]
	Exposure Time	hr/day	1.5	[7]	1.5	[7]	2.5	[7]	2.5	[7]
	HIF(noncancer)	m^3/kg-d	8.45E-04		1.16E-03		4.70E-03		6.43E-03	
	HIF(cancer)	m^3/kg-d	1.09E-04		3.31E-05		2.01E-03		5.52E-04	
Ingestion of Soil	Intake rate	mg/day	50	[5, c]	100	[5, c]	100	[5, c]	200	[5, c]
	Conversion factor	kg/mg	1E-06	--	1E-06	--	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	1.17E-08		4.98E-08		7.83E-08		3.32E-07	
	HIF(cancer)	kg/kg-d	1.51E-09		1.42E-09		3.35E-08		2.85E-08	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] USEPA 1997. Exposure Factors Handbook.

[5] Professional judgment.

[6] USEPA 2001. Rocky Flats Task 3 Report.

[7] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Table 7-3, mean of male and female ages 6 - 12.

[b] Mean breathing rate for moderate and heavy activities (USEPA 1997, Table 5-23).

[c] Assumes soil ingestion is two times the soil ingestion rate of a hiker (for adult); assumes child intake is 2 times the adult rate.

Table C1-2
Exposure Parameters for Hiker - Adult at the Mine Site

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Adult	Source	Adult	Source
General	Body Weight	kg	70	[1, 3]	70	[1, 3]
	Exposure frequency	days/yr	6	[7]	20	[7]
	Exposure duration	yr	9	[3]	30	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	30	[2]
Ingestion of Soil	Ingestion rate	mg/day	25	[4, b]	50	[4, a]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	5.87E-09		3.91E-08	
	HIF(cancer)	kg/kg-d	7.55E-10		1.68E-08	
Ingestion of Sediment	Ingestion rate	mg/day	12.5	[4,b]	25	[4, c]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	2.94E-09		1.96E-08	
	HIF(cancer)	kg/kg-d	3.77E-10		8.39E-09	
Ingestion of Surface Water	Ingestion rate	mL/hour	5	[4, e]	30	[5, d]
	Exposure Time	hr/day	0.5	[4, 6]	1.5	[4, 6]
	Conversion factor	L/mL	1E-03	--	1E-03	--
	HIF(noncancer)	L/kg-d	5.87E-07		3.52E-05	
	HIF(cancer)	L/kg-d	7.55E-08		1.51E-05	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] Professional judgment.

[5] USEPA 1998. Draft Water Quality Criteria Methodology Revisions.

[6] SAF. 2000. Final. Remedial Investigation Report. Zone A. Operable Unit 3: Landfill 6. Volume 3. Appendix K. Baseline Risk Assessment May 15. (FE Warren Site).

[7] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Assumes RME soil ingestion by a recreational visitor is half of the USEPA default soil ingestion rate for a resident.

[b] Assumes CTE ingestion rate is half of the RME ingestion rate.

[c] Assumes RME sediment ingestion is same as CTE soil ingestion.

[d] 30 mL/hr is the basis for the 10 mL/day value proposed for a recreational scenario by the Draft Water Quality Criteria Methodology Revisions (USEPA 1998).

[e] Incidental ingestion from splashing or hand-to-face contact during wading assumed to be 10% of USEPA (1989) recommended default (50 ml/hr) incidentally ingested during swimming.

Table C1-3
Exposure Parameters for Recreational Fishermen - Adult in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Adult	Source	Adult	Source
General	Body Weight	kg	70	[1, 3]	70	[1, 3]
	Exposure duration	yr	9	[3]	30	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	30	[2]
Ingestion of Fish	Ingestion rate (total)	g/day	8	[4, b]	25	[4, b]
	Exposure Frequency	days/yr	234	[3]	350	[2]
	Conversion factor	kg/g	1E-03	--	1E-03	--
	Fraction from Site/Site Impacted areas	unitless	0.10	[5, c]	0.20	[5, c]
	HIF(noncancer)	kg/kg-d	7.33E-06		6.85E-05	
	HIF(cancer)	kg/kg-d	9.42E-07		2.94E-05	
Ingestion of Sediment	Ingestion rate	mg/day	12.5	[5, d]	25	[5, e]
	Exposure Frequency	days/yr	6	[6,a]	20	[6,a]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	2.94E-09		1.96E-08	
	HIF(cancer)	kg/kg-d	3.77E-10		8.39E-09	
Ingestion of Surface Water	Ingestion rate	mL/hour	5	[5, g]	30	[7, f]
	Exposure Frequency	days/yr	6	[6,a]	20	[6,a]
	Exposure Time	hr/day	0.5	[5, 8]	1.5	[5, 8]
	Conversion factor	L/mL	1E-03	--	1E-03	--
	HIF(noncancer)	L/kg-d	5.87E-07		3.52E-05	
	HIF(cancer)	L/kg-d	7.55E-08		1.51E-05	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] USEPA 1997. Exposure Factors Handbook.

[5] Professional judgment.

[6] Community interviews for determining use at the Standard Mine Site. July 2006.

[7] USEPA 1998. Draft Water Quality Criteria Methodology Revisions.

[8] SAF. 2000. Final. Remedial Investigation Report. Zone A. Operable Unit 3: Landfill 6. Volume 3. Appendix K. Baseline Risk Assessment May 15. (FE Warren Site).

Notes:

[a] Assumes exposure frequency is the same as a recreational visitor.

[b] From Section 10.10.3, recommendations for recreational freshwater anglers. RME is equivalent ot 58 meals/year and CTE is equivalent to 19 meals/year (150 g/meal).

[c] assumes 10% and 20% of fish consumed annually are from the drainage areas impacted by the Standard Mine Site.

[d] Assumes CTE ingestion rate is half of the RME ingestion rate.

[e] Assumes RME sediment ingestion is same as CTE soil ingestion.

[f] 30 mL/hr is the basis for the 10 mL/day value proposed for a recreational scenario by the Draft Water Quality Criteria Methodology Revisions (USEPA 1998).

[g] Incidental ingestion from splashing or hand-to-face contact during wading assumed to be 10% of USEPA (1989) recommended default (50 ml/hr) incidentally ingested during swimming.

Table C1-4
Exposure Parameters for Recreational Visitors - Child in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Child	Source	Child	Source
General	Body Weight	kg	33	[3, a]	33	[3, a]
	Exposure duration	yr	2	[2]	6	[2]
	Averaging Time, Cancer	yr	70	[1]	70	[1]
	Averaging Time, Noncancer	yr	2	[1]	6	[1]
Ingestion of Fish	Ingestion rate (total)	g/day	4.0	[g]	12.5	[g]
	Exposure Frequency	days/yr	234	[2]	350	[1]
	Conversion factor	kg/g	1E-03	--	1E-03	--
	Fraction from Site/Site Impacted areas	unitless	0.10	[4, c]	0.20	[4, c]
	HIF(noncancer)	kg/kg-d	7.77E-06		7.26E-05	
	HIF(cancer)	kg/kg-d	2.22E-07		6.23E-06	
Ingestion of Sediment	Ingestion rate	mg/day	25	[4, b]	50	[4, c]
	Exposure Frequency	days/yr	6	[5, d]	20	[5, d]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	1.25E-08		8.30E-08	
	HIF(cancer)	kg/kg-d	3.56E-10		7.12E-09	
Ingestion of Surface Water	Ingestion rate	mL/hour	5	[4, f]	30	[6, e]
	Exposure Frequency	days/yr	6	[5, d]	20	[5, d]
	Exposure Time	hr/day	0.5	[4, 7]	1.5	[4, 7]
	Conversion factor	L/mL	1E-03	--	1E-03	--
	HIF(noncancer)	L/kg-d	1.25E-06		7.47E-05	
	HIF(cancer)	L/kg-d	3.56E-08		6.40E-06	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[2] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.
[3] USEPA 1997. Exposure Factors Handbook.
[4] Professional judgment.
[5] Community interviews for determining use at the Standard Mine Site. July 2006
[6] USEPA 1998. Draft Water Quality Criteria Methodology Revisions.
[7] SAF. 2000. Final. Remedial Investigation Report. Zone A. Operable Unit 3: Landfill 6. Volume 3. Appendix K. Baseline Risk Assessment May 15. (FE Warren Site).

Notes:

[a] Table 7-3, mean of male and female ages 6 - 12.
[b] Assumes CTE ingestion rate is half of the RME ingestion rate.
[c] Assumes RME sediment ingestion is same as CTE soil ingestion.
[d] Assumes that exposure frequency is the same as a recreational visitor.
[e] 30 mL/hr is the basis for the 10 mL/day value proposed for a recreational scenario by the Draft Water Quality Criteria Methodology Revisions (USEPA 1998).
[f] Incidental ingestion from splashing or hand-to-face contact during wading assumed to be 10% of USEPA (1989) recommended default (50 ml/hr) incidentally ingested during swimming.

Table C1-5
Exposure Parameters for Adult Campers in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Adult	Source	Adult	Source
General	Body Weight	kg	70	[1, 3]	70	[1, 3]
	Exposure duration	yr	9	[3]	30	[3]
	Averaging Time, Cancer	yr	70	[2]	70	[2]
	Averaging Time, Noncancer	yr	9	[2]	30	[2]
Ingestion of Sediment	Ingestion rate	mg/day	12.5	[4, a]	25	[4, b]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	2.94E-09		1.96E-08	
	HIF(cancer)	kg/kg-d	3.77E-10		8.39E-09	
Ingestion of Surface Water	Ingestion rate	L/day	1	[2, c]	2	[2, c]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	HIF(noncancer)	L/kg-d	2.35E-04		1.57E-03	
	HIF(cancer)	L/kg-d	3.02E-05		6.71E-04	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

[2] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[3] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[4] Professional judgment.

[5] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Assumes CTE ingestion rate is half of the RME ingestion rate.

[b] Assumes RME sediment ingestion is same as CTE soil ingestion.

[c] Assumes water intake by camper is similar to a resident

Table C1-6
Exposure Parameters for Child Campers in the Drainage

Exposure Pathway	Exposure Input Parameter	Units	CTE		RME	
			Child	Source	Child	Source
General	Body Weight	kg	33	[3, a]	33	[3, a]
	Exposure duration	yr	2	[2]	6	[2]
	Averaging Time, Cancer	yr	70	[1]	70	[1]
	Averaging Time, Noncancer	yr	2	[1]	6	[1]
Ingestion of Sediment	Ingestion rate	mg/day	25	[4, a]	50	[4, b]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	Conversion factor	kg/mg	1E-06	--	1E-06	--
	HIF(noncancer)	kg/kg-d	1.25E-08		8.30E-08	
	HIF(cancer)	kg/kg-d	3.56E-10		7.12E-09	
Ingestion of Surface Water	Ingestion rate	L/day	0.5	[1, c]	1	[1, c]
	Exposure Frequency	days/yr	6	[5]	20	[5]
	HIF(noncancer)	L/kg-d	2.49E-04		1.66E-03	
	HIF(cancer)	L/kg-d	7.12E-06		1.42E-04	

CTE = Central Tendency Exposure
RME = Reasonable Maximum Exposure

Sources:

[1] USEPA 1989. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002. December.

[2] USEPA 1993. Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

[3] USEPA 1997. Exposure Factors Handbook.

[4] Professional judgment.

[5] Community interviews for determining use at the Standard Mine Site. July 2006.

Notes:

[a] Assumes CTE ingestion rate is half of the RME ingestion rate.

[b] Assumes RME sediment ingestion is same as CTE soil ingestion.

[c] Assumes water intake by camper is similar to a resident

Table C1-7. Human Health Toxicity Values

CHEMICAL	INGESTION				INHALATION			
	Oral SF (mg/kg-day)-1	Source	Oral RfD mg/kg-day	Source	Inhalation SF (mg/kg-day)-1	Source	Inhalation RfD mg/kg-day	Source
Aluminum	--	--	1.0E+00	P [2]	--	--	1.0E-03	P [2]
Ammonia	--	--	--	--	--	--	2.9E-02	I
Antimony	--	--	4.0E-04	I	--	--	--	--
Arsenic	1.5E+00	I	3.0E-04	I	1.5E+01	I	--	--
Barium	--	--	2.0E-01	I	--	--	1.40E-04	I
Beryllium	--	--	2.0E-03	I	8.4E+00	I	5.7E-06	I
Cadmium-food	--	--	1.0E-03	I	6.3E+00	I	5.7E-05	E [2]
Cadmium-water	--	--	5.0E-04	I	6.3E+00	I	5.7E-05	E [2]
Chromium III	--	--	1.5E+00	I	--	--	--	--
Chromium VI	--	--	3.0E-03	I	4.1E+01	I	3.0E-05	I
Cobalt	--	--	2.0E-02	P [7]	9.8E+00	P [2]	5.7E-06	P [2]
Copper	--	--	4.0E-02	H [1]	--	--	--	--
Cyanide	--	--	2.0E-02	I [3]	--	--	--	--
Iron	--	--	3.0E-01	E [1]	--	--	--	--
Lithium	--	--	2.0E-02	E [1]	--	--	--	--
Manganese-food	--	--	4.7E-02	I [4]	--	--	1.4E-05	I
Manganese-water	--	--	2.0E-02	I	--	--	1.4E-05	I
Mercury	--	--	3.0E-04	I [5]	--	--	--	--
Methylmercury	--	--	1.0E-04	I [6]	--	--	--	--
Molybdenum	--	--	5.0E-03	I	--	--	--	--
Nickel	--	--	2.0E-02	I	--	[8]	--	--
Nitrate	--	--	1.6E+00	I	--	--	--	--
Nitrite	--	--	1.0E-01	I	--	--	--	--
Selenium	--	--	5.0E-03	I	--	--	--	--
Silver	--	--	5.0E-03	I	--	--	--	--
Strontium	--	--	6.0E-01	I	--	--	--	--
Thallium	--	--	7.0E-05	O [1]	--	--	--	--
Vanadium	--	--	1.0E-03	E [1]	--	--	--	--
Zinc	--	--	3.0E-01	I	--	--	--	--

CSF = Cancer Slope Factor
RfC = Noncancer Reference Concentration
RfD = Noncancer Reference Dose
UR = Unit Risk

I = IRIS
H = HEAST
E = EPA-NCEA Provisional Value
O = Other
P = EPA Provisional Peer-Reviewed Value
-- = A USEPA Recommended toxicity value is not available for this chemical

Notes:

[1] As cited in Region III Tables (10/2006 update): http://www.epa.gov/reg3hwmd/risk/human/index.htm, accessed November, 2006.

[2] As cited in Region III Tables (4/2005 update)

[3] Toxicity data for free cyanide

[4] RfDo (1.4E-01 mg/kg-day) adjusted by a modifying factor of 3, in accord with IRIS and USEPA Region 8 recommendations.

[5] Toxicity data for mercuric chloride. This value is used to evaluate mercury is soil, water and sediment.

[6] Methylmercury value is used to evaluate mercury in fish tissue.

[7] As cited in Region VI Tables (10/2006 update)

[8] An inhalation slope factor does exist for nickel subsulfide and nickel carbonyl in nickel refineries. However, these forms of nickel do not occur in the environment and the slope factor is not representative of exposure that would occur at the site.

Table C1-8. Summary of Risk Based Concentrations (RBCs)

Analyte	Mine			Drainage		
	Soil (mg/kg)	Sediment (mg/kg)	Surface Water (mg/L)	Sediment (mg/kg)	Surface Water (mg/L)	Fish Tissue (mg/kg ww)
	ATV Rider (Child)	Hiker (Adult)	Hiker (Adult)	Recreational Visitor (Child)	Camper (Child)	Fisherman (Child)
Aluminum	12,619	5,110,000	2,839	1,204,500	60	1,377
Antimony	120	2,044	1.14	482	0.024	0.55
Arsenic	23[a]	159	0.044	159[a]	0.005	0.023[a]
Barium	1,789	1,022,000	568	240,900	12	275
Beryllium	50[a]	10,220	5.7	2,409	0.12	2.8
Cadmium	67[a]	5,110	1.42	1,205	0.030	1.4
Chromium	10[a]	15,330	8.5	3,614	0.18	4.1
Cobalt	43[a]	102,200	57	24,090	1.2	28
Copper	12,045	204,400	114	48,180	2.4	55
Cyanide	6,023	102,200	57	24,090	1.2	28
Iron	90,338	1,533,000	852	361,350	18	413
Lead	35,645[a]	405,838	1,218	405,838[a]	3.0[a]	98[a]
Lithium	6,023	102,200	57	24,090	1.2	28
Manganese	186	238,467	57	56,210	1.2	64
Mercury	90	1,533	0.85	361	0.018	0.14
Molybdenum	1,506	25,550	14.2	6,023	0.30	6.9
Nickel	6,023	102,200	57	24,090	1.2	28
Nitrate	481,800	8,176,000	4,542	1,927,200	96	2203
Nitrite	30,113	511,000	284	120,450	6	138
Selenium	1,506	25,550	14.2	6,023	0.30	6.9
Silver	1,506	25,550	14.2	6,023	0.30	6.9
Strontium	180,675	3,066,000	1,703	722,700	36	826
Thallium	21	358	0.20	84	0.0042	0.10
Vanadium	301	5,110	2.8	1,205	0.060	1.4
Zinc	90,338	1,533,000	852	361,350	18	413

(a) Value presented is for the adult camper.

Table C1-9. Soil RBC Calculations for Child ATV Riders at Standard Mine

Analyte	Target Risk		Soil RBA	Noncancer RfD (mg/kg-day) and Cancer SF (mg/kg-day)^1				HIFs				Soil to Air	RBC (mg/kg)	
				Oral		Inhalation		Oral (kg/kg-day)		Inhalation (m^3/kg-day)		PEF	Noncancer	Cancer
	Noncancer	Cancer	(unitless)	Noncancer RfD	Cancer SF	Noncancer RfD	Cancer SF	Noncancer	Cancer	Noncancer	Cancer	(kg/m^3)	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	1.00E-03	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	12,619	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	120	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	--	1.5E+01	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	181	38
Barium	1E-01	1E-06	1.0	2.00E-01	--	1.40E-04	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	1,789	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	5.70E-06	8.4E+00	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	67	183
Cadmium-food	1E-01	1E-06	1.0	1.00E-03	--	5.70E-05	6.3E+00	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	215	244
Cadmium-water	1E-01	1E-06	1.0	5.00E-04	--	5.70E-05	6.3E+00	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	125	244
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	451,688	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	3.00E-05	4.1E+01	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	275	37.5
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	5.70E-06	9.8E+00	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	74	157
Copper	1E-01	1E-06	1.0	4.00E-02	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	12,045	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	6,023	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	90,338	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	6,023	--
Manganese-food	1E-01	1E-06	1.0	4.67E-02	--	1.43E-05	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	186	--
Manganese-water	1E-01	1E-06	1.0	2.00E-02	--	1.43E-05	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	183	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	90	--
Methylmercury	1E-01	1E-06	1.0	1.00E-04	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	30	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	1,506	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	6,023	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	481,800	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	30,113	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	1,506	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	1,506	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	180,675	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	21	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	301	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	--	--	3.32E-07	2.85E-08	6.43E-03	5.52E-04	1.18E-06	90,338	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-10. Soil RBC Calculations for Adult ATV Riders at Standard Mine

Analyte	Target Risk		Soil RBA (unitless)	Noncancer RfD (mg/kg-day) and Cancer SF (mg/kg-day)^1				HIFs				Soil to Air PEF (kg/m^3)	RBC (mg/kg)	
				Oral		Inhalation		Oral (kg/kg-day)		Inhalation (m^3/kg-day)			Noncancer	Cancer
	Noncancer	Cancer		Noncancer RfD	Cancer SF	Noncancer RfD	Cancer SF	Noncancer	Cancer	Noncancer	Cancer		HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	1.00E-03	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	17,792	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	511	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	--	1.5E+01	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	767	23.21
Barium	1E-01	1E-06	1.0	2.00E-01	--	1.40E-04	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	2,501	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	5.70E-06	8.4E+00	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	99	50.12
Cadmium-foo	1E-01	1E-06	1.0	1.00E-03	--	5.70E-05	6.3E+00	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	570	66.83
Cadmium-wate	1E-01	1E-06	1.0	5.00E-04	--	5.70E-05	6.3E+00	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	394	66.83
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	1,916,250	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	3.00E-05	4.1E+01	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	474	10.27
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	5.70E-06	9.8E+00	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	102	42.96
Copper	1E-01	1E-06	1.0	4.00E-02	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	51,100	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	25,550	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	383,250	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	25,550	--
anganese-foo	1E-01	1E-06	1.0	4.67E-02	--	1.43E-05	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	257	--
anganese-wat	1E-01	1E-06	1.0	2.00E-02	--	1.43E-05	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	255	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	383	--
Methylmercur	1E-01	1E-06	1.0	1.00E-04	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	128	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	6,388	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	25,550	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	2,044,000	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	127,750	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	6,388	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	6,388	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	766,500	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	89	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	1,278	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	--	--	7.83E-08	3.35E-08	4.70E-03	2.01E-03	1.18E-06	383,250	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-11. Soil RBC Calculations for Adult Hikers at Standard Mine

Analyte	Target Risk		Soil RBA	Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
				Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(unitless)	(mg/kg-day)	(mg/kg-day)$^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	3.91E-08	1.68E-08	2,555,000	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	3.91E-08	1.68E-08	1,022	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	3.91E-08	1.68E-08	1,533	79
Barium	1E-01	1E-06	1.0	2.00E-01	--	3.91E-08	1.68E-08	511,000	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	3.91E-08	1.68E-08	5,110	--
Cadmium-food	1E-01	1E-06	1.0	1.00E-03	--	3.91E-08	1.68E-08	2,555	--
Cadmium-water	1E-01	1E-06	1.0	5.00E-04	--	3.91E-08	1.68E-08	1,278	--
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	3.91E-08	1.68E-08	3,832,500	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	3.91E-08	1.68E-08	7,665	--
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	3.91E-08	1.68E-08	51,100	--
Copper	1E-01	1E-06	1.0	4.00E-02	--	3.91E-08	1.68E-08	102,200	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	3.91E-08	1.68E-08	51,100	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	3.91E-08	1.68E-08	766,500	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	3.91E-08	1.68E-08	51,100	--
Manganese-food	1E-01	1E-06	1.0	4.67E-02	--	3.91E-08	1.68E-08	119,233	--
Manganese-water	1E-01	1E-06	1.0	2.00E-02	--	3.91E-08	1.68E-08	51,100	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	3.91E-08	1.68E-08	767	--
Methylmercury	1E-01	1E-06	1.0	1.00E-04	--	3.91E-08	1.68E-08	256	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	3.91E-08	1.68E-08	12,775	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	3.91E-08	1.68E-08	51,100	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	3.91E-08	1.68E-08	4,088,000	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	3.91E-08	1.68E-08	255,500	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	3.91E-08	1.68E-08	12,775	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	3.91E-08	1.68E-08	12,775	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	3.91E-08	1.68E-08	1,533,000	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	3.91E-08	1.68E-08	179	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	3.91E-08	1.68E-08	2,555	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	3.91E-08	1.68E-08	766,500	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-12. Sediment RBC Calculations for Adult Hikers at Standard Mine

Analyte	Target Risk		Soil RBA	Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
				Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(unitless)	(mg/kg-day)	(mg/kg-day)$^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	1.96E-08	8.39E-09	5,110,000	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	1.96E-08	8.39E-09	2,044	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	1.96E-08	8.39E-09	3,066	159
Barium	1E-01	1E-06	1.0	2.00E-01	--	1.96E-08	8.39E-09	1,022,000	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	1.96E-08	8.39E-09	10,220	--
Cadmium-food	1E-01	1E-06	1.0	1.00E-03	--	1.96E-08	8.39E-09	5,110	--
Cadmium-water	1E-01	1E-06	1.0	5.00E-04	--	1.96E-08	8.39E-09	2,555	--
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	1.96E-08	8.39E-09	7,665,000	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	1.96E-08	8.39E-09	15,330	--
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Copper	1E-01	1E-06	1.0	4.00E-02	--	1.96E-08	8.39E-09	204,400	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	1.96E-08	8.39E-09	1,533,000	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Manganese-food	1E-01	1E-06	1.0	4.67E-02	--	1.96E-08	8.39E-09	238,467	--
Manganese-water	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	1.96E-08	8.39E-09	1,533	--
Methylmercury	1E-01	1E-06	1.0	1.00E-04	--	1.96E-08	8.39E-09	511	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	1.96E-08	8.39E-09	8,176,000	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	1.96E-08	8.39E-09	511,000	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	1.96E-08	8.39E-09	3,066,000	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	1.96E-08	8.39E-09	358	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	1.96E-08	8.39E-09	5,110	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	1.96E-08	8.39E-09	1,533,000	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-13. Surface Water RBC Calculations for Adult Hikers at Standard Mine

Analyte	Target Risk		Toxicity Values		HIFs (L/kg-day)		RBC (mg/L)	
			Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.00E+00	--	3.52E-05	1.51E-05	2839	--
Antimony	1E-01	1E-06	4.00E-04	--	3.52E-05	1.51E-05	1	--
Arsenic	1E-01	1E-06	3.00E-04	1.50E+00	3.52E-05	1.51E-05	0.85	0.044
Barium	1E-01	1E-06	2.00E-01	--	3.52E-05	1.51E-05	567.8	--
Beryllium	1E-01	1E-06	2.00E-03	--	3.52E-05	1.51E-05	5.7	--
Cadmium-food	1E-01	1E-06	1.00E-03	--	3.52E-05	1.51E-05	3	--
Cadmium-water	1E-01	1E-06	5.00E-04	--	3.52E-05	1.51E-05	1	--
Chromium III	1E-01	1E-06	1.50E+00	--	3.52E-05	1.51E-05	4258	--
Chromium VI	1E-01	1E-06	3.00E-03	--	3.52E-05	1.51E-05	8.5	--
Cobalt	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Copper	1E-01	1E-06	4.00E-02	--	3.52E-05	1.51E-05	113.6	--
Cyanide	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Iron	1E-01	1E-06	3.00E-01	--	3.52E-05	1.51E-05	851.7	--
Lithium	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Manganese-food	1E-01	1E-06	4.67E-02	--	3.52E-05	1.51E-05	132.5	--
Manganese-water	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Mercury	1E-01	1E-06	3.00E-04	--	3.52E-05	1.51E-05	0.9	--
Methylmercury	1E-01	1E-06	1.00E-04	--	3.52E-05	1.51E-05	0.3	--
Molybdenum	1E-01	1E-06	5.00E-03	--	3.52E-05	1.51E-05	14.2	--
Nickel	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Nitrate	1E-01	1E-06	1.60E+00	--	3.52E-05	1.51E-05	4542.2	--
Nitrite	1E-01	1E-06	1.00E-01	--	3.52E-05	1.51E-05	283.9	--
Selenium	1E-01	1E-06	5.00E-03	--	3.52E-05	1.51E-05	14.2	--
Silver	1E-01	1E-06	5.00E-03	--	3.52E-05	1.51E-05	14.2	--
Strontium	1E-01	1E-06	6.00E-01	--	3.52E-05	1.51E-05	1703.3	--
Thallium	1E-01	1E-06	7.00E-05	--	3.52E-05	1.51E-05	0.2	--
Vanadium	1E-01	1E-06	1.00E-03	--	3.52E-05	1.51E-05	2.8	--
Zinc	1E-01	1E-06	3.00E-01	--	3.52E-05	1.51E-05	851.7	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-14. Sediment RBC Calculations for Adult Fishermen in the Drainage

Analyte	Target Risk		Soil RBA	Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
				Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(unitless)	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	1.96E-08	8.39E-09	5,110,000	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	1.96E-08	8.39E-09	2,044	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	1.96E-08	8.39E-09	3,066	159
Barium	1E-01	1E-06	1.0	2.00E-01	--	1.96E-08	8.39E-09	1,022,000	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	1.96E-08	8.39E-09	10,220	--
Cadmium-food	1E-01	1E-06	1.0	1.00E-03	--	1.96E-08	8.39E-09	5,110	--
Cadmium-water	1E-01	1E-06	1.0	5.00E-04	--	1.96E-08	8.39E-09	2,555	--
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	1.96E-08	8.39E-09	7,665,000	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	1.96E-08	8.39E-09	15,330	--
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Copper	1E-01	1E-06	1.0	4.00E-02	--	1.96E-08	8.39E-09	204,400	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	1.96E-08	8.39E-09	1,533,000	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Manganese-food	1E-01	1E-06	1.0	4.67E-02	--	1.96E-08	8.39E-09	238,467	--
Manganese-water	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	1.96E-08	8.39E-09	1,533	--
Methylmercury	1E-01	1E-06	1.0	1.00E-04	--	1.96E-08	8.39E-09	511	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	1.96E-08	8.39E-09	8,176,000	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	1.96E-08	8.39E-09	511,000	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	1.96E-08	8.39E-09	3,066,000	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	1.96E-08	8.39E-09	358	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	1.96E-08	8.39E-09	5,110	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	1.96E-08	8.39E-09	1,533,000	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-15. Surface Water RBC Calculations for Adult Fishermen in the Drainage

Analyte	Target Risk		Toxicity Values		HIFs (L/kg-day)		RBC (mg/L)	
			Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(mg/kg-day)	(mg/kg-day)$^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.00E+00	--	3.52E-05	1.51E-05	2839	--
Antimony	1E-01	1E-06	4.00E-04	--	3.52E-05	1.51E-05	1	--
Arsenic	1E-01	1E-06	3.00E-04	1.50E+00	3.52E-05	1.51E-05	0.9	0.044
Barium	1E-01	1E-06	2.00E-01	--	3.52E-05	1.51E-05	567.8	--
Beryllium	1E-01	1E-06	2.00E-03	--	3.52E-05	1.51E-05	5.7	--
Cadmium-food	1E-01	1E-06	1.00E-03	--	3.52E-05	1.51E-05	3	--
Cadmium-water	1E-01	1E-06	5.00E-04	--	3.52E-05	1.51E-05	1	--
Chromium III	1E-01	1E-06	1.50E+00	--	3.52E-05	1.51E-05	4258	--
Chromium VI	1E-01	1E-06	3.00E-03	--	3.52E-05	1.51E-05	8.5	--
Cobalt	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Copper	1E-01	1E-06	4.00E-02	--	3.52E-05	1.51E-05	113.6	--
Cyanide	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Iron	1E-01	1E-06	3.00E-01	--	3.52E-05	1.51E-05	851.7	--
Lithium	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Manganese-food	1E-01	1E-06	4.67E-02	--	3.52E-05	1.51E-05	132.5	--
Manganese-water	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Mercury	1E-01	1E-06	3.00E-04	--	3.52E-05	1.51E-05	0.9	--
Methylmercury	1E-01	1E-06	1.00E-04	--	3.52E-05	1.51E-05	0.3	--
Molybdenum	1E-01	1E-06	5.00E-03	--	3.52E-05	1.51E-05	14.2	--
Nickel	1E-01	1E-06	2.00E-02	--	3.52E-05	1.51E-05	56.8	--
Nitrate	1E-01	1E-06	1.60E+00	--	3.52E-05	1.51E-05	4542.2	--
Nitrite	1E-01	1E-06	1.00E-01	--	3.52E-05	1.51E-05	283.9	--
Selenium	1E-01	1E-06	5.00E-03	--	3.52E-05	1.51E-05	14.2	--
Silver	1E-01	1E-06	5.00E-03	--	3.52E-05	1.51E-05	14.2	--
Strontium	1E-01	1E-06	6.00E-01	--	3.52E-05	1.51E-05	1703.3	--
Thallium	1E-01	1E-06	7.00E-05	--	3.52E-05	1.51E-05	0.2	--
Vanadium	1E-01	1E-06	1.00E-03	--	3.52E-05	1.51E-05	2.8	--
Zinc	1E-01	1E-06	3.00E-01	--	3.52E-05	1.51E-05	851.7	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-16. Fish Tissue RBC Calculations for Adult Fishermen in the Drainage

Analyte	Target Risk		Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
			Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(mg/kg-day)	(mg/kg-day)$^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.00E+00	--	6.85E-05	2.94E-05	1,460	--
Antimony	1E-01	1E-06	4.00E-04	--	6.85E-05	2.94E-05	0.58	--
Arsenic	1E-01	1E-06	3.00E-04	1.5E+00	6.85E-05	2.94E-05	0.44	0.023
Barium	1E-01	1E-06	2.00E-01	--	6.85E-05	2.94E-05	292	--
Beryllium	1E-01	1E-06	2.00E-03	--	6.85E-05	2.94E-05	2.9	--
Cadmium-food	1E-01	1E-06	1.00E-03	--	6.85E-05	2.94E-05	1.5	--
Cadmium-water	1E-01	1E-06	5.00E-04	--	6.85E-05	2.94E-05	0.73	--
Chromium III	1E-01	1E-06	1.50E+00	--	6.85E-05	2.94E-05	2,190	--
Chromium VI	1E-01	1E-06	3.00E-03	--	6.85E-05	2.94E-05	4.4	--
Cobalt	1E-01	1E-06	2.00E-02	--	6.85E-05	2.94E-05	29	--
Copper	1E-01	1E-06	4.00E-02	--	6.85E-05	2.94E-05	58	--
Cyanide	1E-01	1E-06	2.00E-02	--	6.85E-05	2.94E-05	29	--
Iron	1E-01	1E-06	3.00E-01	--	6.85E-05	2.94E-05	438	--
Lithium	1E-01	1E-06	2.00E-02	--	6.85E-05	2.94E-05	29	--
Manganese-food	1E-01	1E-06	4.67E-02	--	6.85E-05	2.94E-05	68	--
Manganese-water	1E-01	1E-06	2.00E-02	--	6.85E-05	2.94E-05	29	--
Mercury	1E-01	1E-06	3.00E-04	--	6.85E-05	2.94E-05	0.44	--
Methylmercury	1E-01	1E-06	1.00E-04	--	6.85E-05	2.94E-05	0.15	--
Molybdenum	1E-01	1E-06	5.00E-03	--	6.85E-05	2.94E-05	7.3	--
Nickel	1E-01	1E-06	2.00E-02	--	6.85E-05	2.94E-05	29	--
Nitrate	1E-01	1E-06	1.60E+00	--	6.85E-05	2.94E-05	2,336	--
Nitrite	1E-01	1E-06	1.00E-01	--	6.85E-05	2.94E-05	146	--
Selenium	1E-01	1E-06	5.00E-03	--	6.85E-05	2.94E-05	7.3	--
Silver	1E-01	1E-06	5.00E-03	--	6.85E-05	2.94E-05	7.3	--
Strontium	1E-01	1E-06	6.00E-01	--	6.85E-05	2.94E-05	876	--
Thallium	1E-01	1E-06	7.00E-05	--	6.85E-05	2.94E-05	0.10	--
Vanadium	1E-01	1E-06	1.00E-03	--	6.85E-05	2.94E-05	1.5	--
Zinc	1E-01	1E-06	3.00E-01	--	6.85E-05	2.94E-05	438	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-17. Sediment RBC Calculations for Child Visitors in the Drainage

Analyte	Target Risk		Soil RBA	Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
				Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(unitless)	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	8.30E-08	7.12E-09	1,204,500	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	8.30E-08	7.12E-09	482	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	8.30E-08	7.12E-09	723	187
Barium	1E-01	1E-06	1.0	2.00E-01	--	8.30E-08	7.12E-09	240,900	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	8.30E-08	7.12E-09	2,409	--
Cadmium-food	1E-01	1E-06	1.0	1.00E-03	--	8.30E-08	7.12E-09	1,205	--
Cadmium-water	1E-01	1E-06	1.0	5.00E-04	--	8.30E-08	7.12E-09	602	--
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	8.30E-08	7.12E-09	1,806,750	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	8.30E-08	7.12E-09	3,614	--
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Copper	1E-01	1E-06	1.0	4.00E-02	--	8.30E-08	7.12E-09	48,180	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	8.30E-08	7.12E-09	361,350	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Manganese-food	1E-01	1E-06	1.0	4.67E-02	--	8.30E-08	7.12E-09	56,210	--
Manganese-water	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	8.30E-08	7.12E-09	361	--
Methylmercury	1E-01	1E-06	1.0	1.00E-04	--	8.30E-08	7.12E-09	120	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	8.30E-08	7.12E-09	6,023	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	8.30E-08	7.12E-09	1,927,200	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	8.30E-08	7.12E-09	120,450	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	8.30E-08	7.12E-09	6,023	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	8.30E-08	7.12E-09	6,023	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	8.30E-08	7.12E-09	722,700	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	8.30E-08	7.12E-09	84	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	8.30E-08	7.12E-09	1,205	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	8.30E-08	7.12E-09	361,350	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-18. Surface Water RBC Calculations for Child Visitors in the Drainage

Analyte	Target Risk		Toxicity Values		HIFs (L/kg-day)		RBC (mg/L)	
			Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.00E+00	--	7.47E-05	6.40E-06	1338	--
Antimony	1E-01	1E-06	4.00E-04	--	7.47E-05	6.40E-06	1	--
Arsenic	1E-01	1E-06	3.00E-04	1.50E+00	7.47E-05	6.40E-06	0.4	0.1
Barium	1E-01	1E-06	2.00E-01	--	7.47E-05	6.40E-06	267.7	--
Beryllium	1E-01	1E-06	2.00E-03	--	7.47E-05	6.40E-06	2.7	--
Cadmium-food	1E-01	1E-06	1.00E-03	--	7.47E-05	6.40E-06	1	--
Cadmium-water	1E-01	1E-06	5.00E-04	--	7.47E-05	6.40E-06	1	--
Chromium III	1E-01	1E-06	1.50E+00	--	7.47E-05	6.40E-06	2008	--
Chromium VI	1E-01	1E-06	3.00E-03	--	7.47E-05	6.40E-06	4.0	--
Cobalt	1E-01	1E-06	2.00E-02	--	7.47E-05	6.40E-06	26.8	--
Copper	1E-01	1E-06	4.00E-02	--	7.47E-05	6.40E-06	53.5	--
Cyanide	1E-01	1E-06	2.00E-02	--	7.47E-05	6.40E-06	26.8	--
Iron	1E-01	1E-06	3.00E-01	--	7.47E-05	6.40E-06	401.5	--
Lithium	1E-01	1E-06	2.00E-02	--	7.47E-05	6.40E-06	26.8	--
Manganese-food	1E-01	1E-06	4.67E-02	--	7.47E-05	6.40E-06	62.5	--
Manganese-water	1E-01	1E-06	2.00E-02	--	7.47E-05	6.40E-06	26.8	--
Mercury	1E-01	1E-06	3.00E-04	--	7.47E-05	6.40E-06	0.4	--
Methylmercury	1E-01	1E-06	1.00E-04	--	7.47E-05	6.40E-06	0.1	--
Molybdenum	1E-01	1E-06	5.00E-03	--	7.47E-05	6.40E-06	6.7	--
Nickel	1E-01	1E-06	2.00E-02	--	7.47E-05	6.40E-06	26.8	--
Nitrate	1E-01	1E-06	1.60E+00	--	7.47E-05	6.40E-06	2141.3	--
Nitrite	1E-01	1E-06	1.00E-01	--	7.47E-05	6.40E-06	133.8	--
Selenium	1E-01	1E-06	5.00E-03	--	7.47E-05	6.40E-06	6.7	--
Silver	1E-01	1E-06	5.00E-03	--	7.47E-05	6.40E-06	6.7	--
Strontium	1E-01	1E-06	6.00E-01	--	7.47E-05	6.40E-06	803.0	--
Thallium	1E-01	1E-06	7.00E-05	--	7.47E-05	6.40E-06	0.1	--
Vanadium	1E-01	1E-06	1.00E-03	--	7.47E-05	6.40E-06	1.3	--
Zinc	1E-01	1E-06	3.00E-01	--	7.47E-05	6.40E-06	401.5	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-19. Fish Tissue RBC Calculations for Child Fishermen in the Drainage

Analyte	Target Risk		Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
			Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.00E+00	--	7.26E-05	6.23E-06	1,377	--
Antimony	1E-01	1E-06	4.00E-04	--	7.26E-05	6.23E-06	0.55	--
Arsenic	1E-01	1E-06	3.00E-04	1.5E+00	7.26E-05	6.23E-06	0.41	0.11
Barium	1E-01	1E-06	2.00E-01	--	7.26E-05	6.23E-06	275	--
Beryllium	1E-01	1E-06	2.00E-03	--	7.26E-05	6.23E-06	2.75	--
Cadmium-food	1E-01	1E-06	1.00E-03	--	7.26E-05	6.23E-06	1.38	--
Cadmium-water	1E-01	1E-06	5.00E-04	--	7.26E-05	6.23E-06	0.7	--
Chromium III	1E-01	1E-06	1.50E+00	--	7.26E-05	6.23E-06	2,065	--
Chromium VI	1E-01	1E-06	3.00E-03	--	7.26E-05	6.23E-06	4.13	--
Cobalt	1E-01	1E-06	2.00E-02	--	7.26E-05	6.23E-06	28	--
Copper	1E-01	1E-06	4.00E-02	--	7.26E-05	6.23E-06	55	--
Cyanide	1E-01	1E-06	2.00E-02	--	7.26E-05	6.23E-06	28	--
Iron	1E-01	1E-06	3.00E-01	--	7.26E-05	6.23E-06	413	--
Lithium	1E-01	1E-06	2.00E-02	--	7.26E-05	6.23E-06	28	--
Manganese-food	1E-01	1E-06	4.67E-02	--	7.26E-05	6.23E-06	64	--
Manganese-water	1E-01	1E-06	2.00E-02	--	7.26E-05	6.23E-06	27.5	--
Mercury	1E-01	1E-06	3.00E-04	--	7.26E-05	6.23E-06	0.41	--
Methylmercury	1E-01	1E-06	1.00E-04	--	7.26E-05	6.23E-06	0.14	--
Molybdenum	1E-01	1E-06	5.00E-03	--	7.26E-05	6.23E-06	6.9	--
Nickel	1E-01	1E-06	2.00E-02	--	7.26E-05	6.23E-06	28	--
Nitrate	1E-01	1E-06	1.60E+00	--	7.26E-05	6.23E-06	2,203	--
Nitrite	1E-01	1E-06	1.00E-01	--	7.26E-05	6.23E-06	138	--
Selenium	1E-01	1E-06	5.00E-03	--	7.26E-05	6.23E-06	6.9	--
Silver	1E-01	1E-06	5.00E-03	--	7.26E-05	6.23E-06	6.9	--
Strontium	1E-01	1E-06	6.00E-01	--	7.26E-05	6.23E-06	826	--
Thallium	1E-01	1E-06	7.00E-05	--	7.26E-05	6.23E-06	0.096	--
Vanadium	1E-01	1E-06	1.00E-03	--	7.26E-05	6.23E-06	1.4	--
Zinc	1E-01	1E-06	3.00E-01	--	7.26E-05	6.23E-06	413	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-20. Sediment RBC Calculations for Adult Campers in the Drainage

Analyte	Target Risk		Soil RBA	Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
				Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(unitless)	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	1.96E-08	8.39E-09	5,110,000	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	1.96E-08	8.39E-09	2,044	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	1.96E-08	8.39E-09	3,066	159
Barium	1E-01	1E-06	1.0	2.00E-01	--	1.96E-08	8.39E-09	1,022,000	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	1.96E-08	8.39E-09	10,220	--
Cadmium-food	1E-01	1E-06	1.0	1.00E-03	--	1.96E-08	8.39E-09	5,110	--
Cadmium-water	1E-01	1E-06	1.0	5.00E-04	--	1.96E-08	8.39E-09	2,555	--
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	1.96E-08	8.39E-09	7,665,000	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	1.96E-08	8.39E-09	15,330	--
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Copper	1E-01	1E-06	1.0	4.00E-02	--	1.96E-08	8.39E-09	204,400	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	1.96E-08	8.39E-09	1,533,000	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Manganese-food	1E-01	1E-06	1.0	4.67E-02	--	1.96E-08	8.39E-09	238,467	--
Manganese-water	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	1.96E-08	8.39E-09	1,533	--
Methylmercury	1E-01	1E-06	1.0	1.00E-04	--	1.96E-08	8.39E-09	511	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	1.96E-08	8.39E-09	102,200	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	1.96E-08	8.39E-09	8,176,000	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	1.96E-08	8.39E-09	511,000	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	1.96E-08	8.39E-09	25,550	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	1.96E-08	8.39E-09	3,066,000	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	1.96E-08	8.39E-09	358	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	1.96E-08	8.39E-09	5,110	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	1.96E-08	8.39E-09	1,533,000	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-21. Surface Water RBC Calculations for Adult Campers in the Drainage

Analyte	Target Risk		Toxicity Values		HIFs (L/kg-day)		RBC (mg/L)	
			Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(mg/kg-day)	(mg/kg-day)$^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.00E+00	--	1.57E-03	6.71E-04	64	--
Antimony	1E-01	1E-06	4.00E-04	--	1.57E-03	6.71E-04	0	--
Arsenic	1E-01	1E-06	3.00E-04	1.50E+00	1.57E-03	6.71E-04	0.019	0.001
Barium	1E-01	1E-06	2.00E-01	--	1.57E-03	6.71E-04	12.8	--
Beryllium	1E-01	1E-06	2.00E-03	--	1.57E-03	6.71E-04	0.1	--
Cadmium-food	1E-01	1E-06	1.00E-03	--	1.57E-03	6.71E-04	0	--
Cadmium-water	1E-01	1E-06	5.00E-04	--	1.57E-03	6.71E-04	0	--
Chromium III	1E-01	1E-06	1.50E+00	--	1.57E-03	6.71E-04	96	--
Chromium VI	1E-01	1E-06	3.00E-03	--	1.57E-03	6.71E-04	0.2	--
Cobalt	1E-01	1E-06	2.00E-02	--	1.57E-03	6.71E-04	1.3	--
Copper	1E-01	1E-06	4.00E-02	--	1.57E-03	6.71E-04	2.6	--
Cyanide	1E-01	1E-06	2.00E-02	--	1.57E-03	6.71E-04	1.3	--
Iron	1E-01	1E-06	3.00E-01	--	1.57E-03	6.71E-04	19.2	--
Lithium	1E-01	1E-06	2.00E-02	--	1.57E-03	6.71E-04	1.3	--
Manganese-food	1E-01	1E-06	4.67E-02	--	1.57E-03	6.71E-04	3.0	--
Manganese-water	1E-01	1E-06	2.00E-02	--	1.57E-03	6.71E-04	1.3	--
Mercury	1E-01	1E-06	3.00E-04	--	1.57E-03	6.71E-04	0.0	--
Methylmercury	1E-01	1E-06	1.00E-04	--	1.57E-03	6.71E-04	0.0	--
Molybdenum	1E-01	1E-06	5.00E-03	--	1.57E-03	6.71E-04	0.3	--
Nickel	1E-01	1E-06	2.00E-02	--	1.57E-03	6.71E-04	1.3	--
Nitrate	1E-01	1E-06	1.60E+00	--	1.57E-03	6.71E-04	102.2	--
Nitrite	1E-01	1E-06	1.00E-01	--	1.57E-03	6.71E-04	6.4	--
Selenium	1E-01	1E-06	5.00E-03	--	1.57E-03	6.71E-04	0.3	--
Silver	1E-01	1E-06	5.00E-03	--	1.57E-03	6.71E-04	0.3	--
Strontium	1E-01	1E-06	6.00E-01	--	1.57E-03	6.71E-04	38.3	--
Thallium	1E-01	1E-06	7.00E-05	--	1.57E-03	6.71E-04	0.0	--
Vanadium	1E-01	1E-06	1.00E-03	--	1.57E-03	6.71E-04	0.1	--
Zinc	1E-01	1E-06	3.00E-01	--	1.57E-03	6.71E-04	19.2	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-22. Sediment RBC Calculations for Child Campers in the Drainage

Analyte	Target Risk		Soil RBA	Toxicity Values		HIFs (kg/kg-day)		RBC (mg/kg)	
				Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(unitless)	(mg/kg-day)	(mg/kg-day)$^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.0	1.00E+00	--	8.30E-08	7.12E-09	1,204,500	--
Antimony	1E-01	1E-06	1.0	4.00E-04	--	8.30E-08	7.12E-09	482	--
Arsenic	1E-01	1E-06	0.5	3.00E-04	1.5E+00	8.30E-08	7.12E-09	723	187
Barium	1E-01	1E-06	1.0	2.00E-01	--	8.30E-08	7.12E-09	240,900	--
Beryllium	1E-01	1E-06	1.0	2.00E-03	--	8.30E-08	7.12E-09	2,409	--
Cadmium-food	1E-01	1E-06	1.0	1.00E-03	--	8.30E-08	7.12E-09	1,205	--
Cadmium-water	1E-01	1E-06	1.0	5.00E-04	--	8.30E-08	7.12E-09	602	--
Chromium III	1E-01	1E-06	1.0	1.50E+00	--	8.30E-08	7.12E-09	1,806,750	--
Chromium VI	1E-01	1E-06	1.0	3.00E-03	--	8.30E-08	7.12E-09	3,614	--
Cobalt	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Copper	1E-01	1E-06	1.0	4.00E-02	--	8.30E-08	7.12E-09	48,180	--
Cyanide	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Iron	1E-01	1E-06	1.0	3.00E-01	--	8.30E-08	7.12E-09	361,350	--
Lithium	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Manganese-food	1E-01	1E-06	1.0	4.67E-02	--	8.30E-08	7.12E-09	56,210	--
Manganese-water	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Mercury	1E-01	1E-06	1.0	3.00E-04	--	8.30E-08	7.12E-09	361	--
Methylmercury	1E-01	1E-06	1.0	1.00E-04	--	8.30E-08	7.12E-09	120	--
Molybdenum	1E-01	1E-06	1.0	5.00E-03	--	8.30E-08	7.12E-09	6,023	--
Nickel	1E-01	1E-06	1.0	2.00E-02	--	8.30E-08	7.12E-09	24,090	--
Nitrate	1E-01	1E-06	1.0	1.60E+00	--	8.30E-08	7.12E-09	1,927,200	--
Nitrite	1E-01	1E-06	1.0	1.00E-01	--	8.30E-08	7.12E-09	120,450	--
Selenium	1E-01	1E-06	1.0	5.00E-03	--	8.30E-08	7.12E-09	6,023	--
Silver	1E-01	1E-06	1.0	5.00E-03	--	8.30E-08	7.12E-09	6,023	--
Strontium	1E-01	1E-06	1.0	6.00E-01	--	8.30E-08	7.12E-09	722,700	--
Thallium	1E-01	1E-06	1.0	7.00E-05	--	8.30E-08	7.12E-09	84	--
Vanadium	1E-01	1E-06	1.0	1.00E-03	--	8.30E-08	7.12E-09	1,205	--
Zinc	1E-01	1E-06	1.0	3.00E-01	--	8.30E-08	7.12E-09	361,350	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C1-23. Surface Water RBC Calculations for Child Campers in the Drainage

Analyte	Target Risk		Toxicity Values		HIFs (L/kg-day)		RBC (mg/L)	
			Noncancer RfD	Cancer SF			Noncancer	Cancer
	Noncancer	Cancer	(mg/kg-day)	(mg/kg-day)$^{-1}$	Noncancer	Cancer	HQ = 1E-01	Risk = 1E-06
Aluminum	1E-01	1E-06	1.00E+00	--	1.66E-03	1.42E-04	60	--
Antimony	1E-01	1E-06	4.00E-04	--	1.66E-03	1.42E-04	0	--
Arsenic	1E-01	1E-06	3.00E-04	1.50E+00	1.66E-03	1.42E-04	0.018	0.005
Barium	1E-01	1E-06	2.00E-01	--	1.66E-03	1.42E-04	12.0	--
Beryllium	1E-01	1E-06	2.00E-03	--	1.66E-03	1.42E-04	0.1	--
Cadmium-food	1E-01	1E-06	1.00E-03	--	1.66E-03	1.42E-04	0	--
Cadmium-water	1E-01	1E-06	5.00E-04	--	1.66E-03	1.42E-04	0	--
Chromium III	1E-01	1E-06	1.50E+00	--	1.66E-03	1.42E-04	90	--
Chromium VI	1E-01	1E-06	3.00E-03	--	1.66E-03	1.42E-04	0.2	--
Cobalt	1E-01	1E-06	2.00E-02	--	1.66E-03	1.42E-04	1.2	--
Copper	1E-01	1E-06	4.00E-02	--	1.66E-03	1.42E-04	2.4	--
Cyanide	1E-01	1E-06	2.00E-02	--	1.66E-03	1.42E-04	1.2	--
Iron	1E-01	1E-06	3.00E-01	--	1.66E-03	1.42E-04	18.1	--
Lithium	1E-01	1E-06	2.00E-02	--	1.66E-03	1.42E-04	1.2	--
Manganese-food	1E-01	1E-06	4.67E-02	--	1.66E-03	1.42E-04	2.8	--
Manganese-water	1E-01	1E-06	2.00E-02	--	1.66E-03	1.42E-04	1.2	--
Mercury	1E-01	1E-06	3.00E-04	--	1.66E-03	1.42E-04	0.0	--
Methylmercury	1E-01	1E-06	1.00E-04	--	1.66E-03	1.42E-04	0.0	--
Molybdenum	1E-01	1E-06	5.00E-03	--	1.66E-03	1.42E-04	0.3	--
Nickel	1E-01	1E-06	2.00E-02	--	1.66E-03	1.42E-04	1.2	--
Nitrate	1E-01	1E-06	1.60E+00	--	1.66E-03	1.42E-04	96.4	--
Nitrite	1E-01	1E-06	1.00E-01	--	1.66E-03	1.42E-04	6.0	--
Selenium	1E-01	1E-06	5.00E-03	--	1.66E-03	1.42E-04	0.3	--
Silver	1E-01	1E-06	5.00E-03	--	1.66E-03	1.42E-04	0.3	--
Strontium	1E-01	1E-06	6.00E-01	--	1.66E-03	1.42E-04	36.1	--
Thallium	1E-01	1E-06	7.00E-05	--	1.66E-03	1.42E-04	0.0	--
Vanadium	1E-01	1E-06	1.00E-03	--	1.66E-03	1.42E-04	0.1	--
Zinc	1E-01	1E-06	3.00E-01	--	1.66E-03	1.42E-04	18.1	--

RME = Reasonable Maximum Exposure
HIF = Human Intake Factor
PEF = Particulate Emission Factor
RBC = Risk Based Concentration

Table C2-1. Adult Lead Model Inputs

Parameter	**Unit**	**ATV Rider Onsite**	**Hiker in Onsite Mining Area**			**Recreational Fisherman in Drainage Area**			**Adult Camper in Drainage Area**		**Source**	**Notes**
		Soil	**Soil**	**Surface Water**	**Sediment**	**Fish Tissue**	**Surface Water**	**Sediment**	**Surface Water**	**Sediment**		
PbB0	ug/dL	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	AGEISS 1996	Bingham Creek Study
BKSF	ug/dL per ug/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	USEPA 2003a	USEPA default recommendation
IR_{soil}	mg/day	50	25	--	--	--	--	--	--	--	Professional Judgement	CTE exposure parameter
EF_{soil}	days/yr	6	6	--	--	--	--	--	--	--	Community Interviews	CTE exposure parameter
BR_{air}	m^3/hr	2.4	--	--	--	--	--	--	--	--	USEPA 1997	Mean breathing rate for moderate and heavy activities.
$IR_{fish\ tissue}$	g/day	--	--	--	--	8	--	--	--	--	USEPA 1997	CTE exposure parameter
$F_{fish\ tissue}$	(unitless)	--	--	--	--	0.1	--	--	--	--	Professional Judgement	Assumes 10% of fish ingested are from th Standard Mine site
$EF_{fish\ tissue}$	days/yr	--	--	--	--	234	--	--	--	--	USEPA 1993	CTE exposure parameter
EF_{air}	days/yr	6	--	--	--	--	--	--	--	--	Community Interviews	CTE exposure parameter
$IR_{sediment}$	mg/day	--	--	--	12.5	--	--	12.5	--	12.5	Professional Judgement	CTE exposure parameter
$IR_{surface\ water}$	L/day	--	--	0.0025	--	--	0.0025	--	1	--	Professional Judgement	CTE exposure parameter. Assumes 5 mL/hour; 0.5 hours/day.
$EF_{sediment/surface\ water}$	days/yr	--	--	6	6	--	6	6	6	6	Community Interviews	CTE exposure parameter
PEF	kg/m^3	1.18E-06	--	--	--	--	--	--	--	--	Appendix F	Appendix F - PEF Derivation.
AF	(unitless)	0.12	0.12	0.2	0.12	0.2	0.2	0.12	0.2	0.12	USEPA 2003a	For soil and sediment: 0.2 (default) * 0.6 (RBA) For fish and surface water: 0.2 (default) * 1 (RBA)
$Ratio_{fetal/maternal}$	(unitless)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	USEPA 2003a	USEPA default recommendation
GSD	(unitless)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	AGEISS 1996	Bingham Creek Study

-- = Model input not applicable to this receptor.

AGEISS 1996.

USEPA 1993. Superfund's standard Default Exposure Factors for the CTE and RME.

USEPA 1997. Exposure Factors Handbook

USEPA 2002a. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.

USEPA 2003a. Recommendations of the Technical Review Workgroup for Lead - an approach for assessing risks associated with adult exposure to lead in soil.

Table C2-2. Summary of Lead RBCs

Location	Receptor	Medium	RBC	Units
On-site	ATV Rider	Soil	59,408	mg/kg
	Hiker	Sediment	405,838	mg/kg
		Surface Water	1,218	mg/L
Drainages	Fisherman	Sediment	405,838	mg/kg
		Surface Water	1,218	mg/L
		Fish Tissue	98	mg/kg ww
	Camper	Sediment	405,838	mg/kg
		Surface Water	3.0	mg/L

Table C2-3

RBC for Exposure of On-Site Recreational Visitors to Lead in Soil by Ingestion and Inhalation

Basic Equations
PbB(fetus) = PbB(mother) * Ratio
PbB(mother) = PbB0 + BKSF*[Csoil*IRsoil*AFsoil*EF/365 + Csoil*PEF*BR*AFa*EF/365]

Parameter	Units	Adult ATV Rider	Adult Hiker
PbB0	ug/dL	1.7	1.7
BKSF	ug/dL per ug/day	0.4	0.4
Ratio	ug/dL per ug/dL	0.9	0.9
GSD	--	1.5	1.5
Csoil	ug/g	59,408	202,936
IRsoil	g/day	0.050	0.025
AFsoil	ug absorbed per ug ingested	0.12	0.12
PEF	g/m3	1.18E-03	0
BR	m3/hr	2.4	2.4
ET	hrs/day	1.5	1.5
AFa		1.00	1.00
EF	days/yr	6	6
ID soil	ug/day	48.83	83.40
IDair	ug/day	4.148	0.00
AD soil	ug/day	5.859	10.008
AD inhal	ug/day	4.148	0.000
AD total	ug/day	10.008	10.008
PbB(mom)	ug/dL	5.703	5.703
PbB(fetus)	ug/dL	5.133	5.133
mu		1.6357	1.6357
sigma		0.405	0.405
P10		5.00%	5.00%

Final RBC	59,408	ug/g

Table C2-4
RBC for Exposure of Recreational Visitors to Lead in Water by Incidental Ingestion

Basic Equations

PbB = PbB0 + BKSF*AD
AD = ID * AF
ID = C * IR * EF/365
PbB(95th) = GM*GSD^1.645
Target 95th(fetal) = 10 / Ratio

where

PbB = Geomean PbB in exposed population
PbB0 = Baseline GM PbB in exposed population
BKSF = Biokinetic slope factor (ug/dL increase in PbB per ug/day absorbed)
ID = Ingested dose of lead (ug/day)
AD = Absorbed dose (ug/day)
AF = Absorption Fraction
C = Concentration of lead
IR = Intake rate
EF = Exposure frequency
Ratio = Fetal to maternal PbB ratio

			On-site Hiker	Drainage Fisherman	Drainage Adult Camper
INPUTS					
	C(water)	ug/L	1,217,515	1,217,515	3,044
	PbB0	ug/dL	1.7	1.7	1.7
	BKSF	ug/dL per ug/day	0.4	0.4	0.4
	IR	L/day	0.0025	0.0025	1
	EF	days/yr	6	6	6
	AF		0.2	0.2	0.2
	ratio		0.9	0.9	0.9
	GSD		1.5	1.5	1.5
Results					
	ID	ug/day	50.0	50	50
	AD	ug/day	10.0	10.0	10
	PbB (GM, adult)	ug/dL	5.70	5.70	5.70
	PbB(95th, fetal)	ug/dL	10.00	10.00	10.00
Final RBC		ug/L	1,217,515	1,217,515	3,044

Table C2-5

RBC for Exposure of Recreational Visitors to Lead in Sediment by Incidental Ingestion

Basic Equations

PbB = PbB0 + BKSF*AD
AD = ID * AF
ID = C * IR * EF/365
PbB(95th) = GM*GSD^1.645
Target 95th(fetal) = 10 / Ratio

where

PbB = Geomean PbB in exposed population
PbB0 = Baseline GM PbB in exposed population
BKSF = Biokinetic slope factor (ug/dL increase in PbB per ug/day absorbed)
ID = Ingested dose of lead (ug/day)
AD = Absorbed dose (ug/day)
AF = Absorption Fraction
C = Concentration of lead
IR = Intake rate
EF = Exposure frequency
Ratio = Fetal to maternal PbB ratio

			Drainage Fisherman	On-Site Hiker	Drainage Adult Camper
INPUTS					
	C(sediment)	ug/g	405,838	405,838	405,838
	PbB0	ug/dL	1.7	1.7	1.7
	BKSF	ug/dL per ug/day	0.4	0.4	0.4
	IR	mg/day	12.5	12.5	12.5
	EF	days/yr	6	6	6
	AF		0.12	0.12	0.12
	ratio		0.9	0.9	0.9
	GSD		1.5	1.5	1.5
Results					
	ID	ug/day	83.4	83.4	83.4
	AD	ug/day	10.0	10.0	10.0
	PbB (GM, adult)	ug/dL	5.70	5.70	5.70
	PbB(95th, fetal)	ug/dL	10.00	10.00	10.00
Final RBC		ug/g	405,838	405,838	405,838

Table C2-6

RBC for Exposure of Recreational Visitors in the Drainages to Lead in Fish

Basic Equations

PbB = PbB0 + BKSF*AD
AD = ID * AF
ID = C * IR * EF/365
PbB(95th) = GM*GSD^1.645
Target 95th(fetal) = 10 / Ratio

where

PbB = Geomean PbB in exposed population
PbB0 = Baseline GM PbB in exposed population
BKSF = Biokinetic slope factor (ug/dL increase in PbB per ug/day absorbed)
ID = Ingested dose of lead (ug/day)
AD = Absorbed dose (ug/day)
AF = Absorption Fraction
C = Concentration of lead
IR = Intake rate (g/day total)
F = fraction of total fish from the site
EF = Exposure frequency
Ratio = Fetal to maternal PbB ratio

INPUTS			Drainage Fisherman
	C(fish)	ug/g	98
	PbB0	ug/dL	1.7
	BKSF	ug/dL per ug/day	0.4
	IR	g/day	8
	$F_{\text{fish tissue}}$	--	0.1
	EF	days/yr	234
	AF		0.2
	ratio		0.9
	GSD		1.5
Results			
	ID	ug/day	50
	AD	ug/day	10.0
	PbB (GM, adult)	ug/dL	5.70
	PbB(95th, fetal)	ug/dL	10.00

Final RBC	ug/g ww	98

This page intentionally left blank to facilitate double-sided printing.

APPENDIX D

COMMUNITY INTERVIEWS FOR DETERMINING LAND USE AT THE STANDARD MINE SITE

July 27, 2006

Community Interviews for Determining
Land Use at the Standard Mine Site
Crested Butte, Colorado – July 27, 2006
Written by Libby Faulk

Interview Summary and Area Statistics

Interviews were voluntary and done by phone, email, and in person. There were three public notices in the newspaper and fact sheets posted throughout the town to make the community aware of EPA's interest in information about recreational use at the Standard Mine. The following is a summary of the responses to the 9 questions as well as information on the demographics of those that responded:

Total Adult Responders – 29
20 to 29 – 4
30 to 39 – 2
40 to 49 – 6
50 to 59 – 8
60 to 69 – 1
70 to 69 – 1
No age given – 7

Number of Males responders – 11
Number of Female responders – 18

According to the 2000 U.S. Census, Crested Butte population breakout was the following:

Crested Butte town, Colorado Statistics and Demographics (US Census 2000)

	Number	Percent
Crested Butte Population:	1529	100.00%
Sex and Age		
Male	848	55.46%
Female	681	44.54%
Under 5 years	59	3.86%
5 to 9 years	46	3.01%
10 to 14 years	60	3.92%
15 to 19 years	56	3.66%
20 to 24 years	162	10.6%
25 to 34 years	590	38.59%

35 to 44 years	260	17%
45 to 54 years	207	13.54%
55 to 59 years	43	2.81%
60 to 64 years	17	1.11%
65 to 74 years	22	1.44%
75 to 84 years	7	0.46%
85 years and over	0	0%
Median age (years)	30.6	

Questions and Responses

Current Land Use

1. What are the current land uses at the Standard Mine Site? (check all that apply)

- Residential
- Commercial/Industrial
- Recreational
- Other (Please specify)

All 29 responders believed recreational was one of the current land uses taking place at our around the Standard Mine Site. Of the responses received, 6 believed there was some level of commercial activity taking place in the area such as hiking tours. Of the responses received, 4 responders believed there's current residential use in the area.

2. For those land uses checked above, except residential, what type of activities do people engage in?

- ATV and motorcycle riding
- Hiking, mountain biking
- Camping
- Skiing, Snowmobiling
- Fishing
- Mining
- Other (please specify)

Of the choices above, we received the following response:

- ATV and motorcycle riding – 14
- Hiking, mountain biking – 28
- Camping – 6
- Skiing, Snowmobiling – 17
- Fishing – 0

- Mining – 0
- Other (please specify)
    1. horseback riding
    2. rock hounding
    3. biomonitoring
    4. snowboarding
    5. hiking with dog who may be drinking the water
    6. One responder witnessed a jeep in the area.

3. How often do people engage in the activities checked above? (please specify for all activities checked above)

    - Number of hours per event
    - Number of days per year
    - Number of years

Many responders were not sure how long people spend time in the Standard Mine area but most responders felt that the time spent would be very little. The reason stated for this is because they believed most people would just be passing through the site and not hanging around the site itself. For those that did respond, they responded with the following:

- Number of hours per event – under 5 hours per event with the exception of one response that state 10 hours per event and another 24 hours or more. The person that responded with 24 hours or more has property in the area.
- Number of days per year
    - Under 5 days – 11
    - 6 to 10 days – 3
    - 11 to 15 days – 2
    - 16 to 20 days – 0
    - Over 20 days – 1

  * One person that responded stated she was up there 250 to 300 times per year.
- Number of years
    - 1 to 5 yrs. – 9
    - 6 to 10 yrs. – 3
    - 11 to 20 yrs. – 3
    - Over 20 yrs. – 5

General Comments Received:

- The numbers may be increasing because of the interest around the clean-up of the mine and people wanting to see what the ruckus is all about.
- For mountain bikers under an hour and for motorized users maybe more time.

- Some probably just pass right on through or turnaround because they missed the trail head to Copley Lake.

4. Do you bring your children with you? If so, what are their ages?

Of those that responded to this question, 12 do not have children. For those that have children, 11 of them said they do not take their children with them to that area and one said their child has only been to Copley Lake which is below the Standard Mine, another responder said she took her daughter there once at age 11 but she's not 28, and one responder said that her kids have been up in the area a long time ago but not recently. Her children are now ages 14 and 18. I did not get the ages of the children where the parents stated that they have never taken their children up to the Standard Mine site.

General Comments:

- The area of hiking is too steep for children to hike.
- Don't have any and have never seen any up there when I've been up there. It seems that the hike would be too steep for children.
- Too far up and steep.
- Only up to Copley Lake
- We shouldn't assume that children are not hiking in the area because there are quite a few families that do lots of hiking in the area.
- You'll see kids on ATVs and motorbikes riding around.

5. If you fish, where do you fish? (Please describe location of where on site fishing is occurring, for example, at the site itself, along Elk Creek below the site, Coal Creek).

No one responded as having fished in the area.

6. How many fish do you catch each year from this site? Do you eat all of the fish you catch? When you prepare the fish, do you prepare just the fillets or do you include other parts of the fish?

See response to #5 above.

Future Land Use

1. What do you think are the most likely land uses for the Standard Mine site in the future? (Check all that apply)

    - Residential
    - Commercial/Industrial
    - Recreational
    - Other (please specify)

All 29 responders believed that in the future, recreational use would continue to be the main use in and around the Standard Mine area. Of all the responders, 9 of the responders felt that residential development could occur in the area, 7 felt there could be commercial interest such as tours in the area.

2. For each of the land uses checked above, please explain the basis for your answer. For example, if residential land use is checked, is this based on zoning ordinances, county planning, recent property purchases, development plans, etc.

Many of the responses received to this question were the same from each responder. The comments received were the following:

- Continue to be the same recreational activities as is occurring in the area now.
- There could be an increase in commercial activity for touring in the area.
- The Township of Irwin is close by and growing and so residential development is bound to spill over into the Elk Basin area.
- There's private property in the area so there will probably be an increase in residential development at some point.
- You may see more tours for historical and educational purposes.
- Recreational only - Climate, location and elevation.
- Will depend on road improvements to the area that would make it more accessible.
- Doubts much due to steepness of the area and difficulty in getting to the mine site.
- Recreational only - Location, terrain, and precipitation.
- Recreational only – location, accessibility, and demand.

3. For those land uses checked above, except residential, what are the most likely activities you think people may engage in?

- ATV and motorcycle riding
- Hiking, mountain biking
- Camping
- Skiing, Snowmobiling
- Fishing
- Mining
- Other (please specify)

Of the choices above, we received the following response:

- ATV and motorcycle riding – 17
- Hiking, mountain biking – 29
- Camping – 10
- Skiing, Snowmobiling – 19
- Fishing – 0

- Mining – 0
- Other (please specify)
  1. horseback riding
  2. biomonitoring
  3. educational tours (hiking)
  4. Jeeps 4-wheeling
  5. rock hounding
  6. hunting

General Comments Received:

- Camping may increase but probably around Copley Lake and not up at the mine site itself.

Other general suggestions or comments that responder's mentioned during the interviews or on their interview sheet were:

1. If the U.S.F.S would clearly mark the trail head to Copley Lake, less people would end up at the Standard Mine site.

2. Someone should evaluate the risk of hunting wildlife in and around the Standard Mine site because the elk and deer in the area probably drink out of the creek and pond. What would the mean for someone who eventually ate the elk or deer?

3. People probably don't typically come across the mine because it's not easy to stumble across.

4. There's a lot of private property in the area making it difficult to get to the site without crossing over someone's property.

5. There are gates in various areas making it difficult to get to the site.

6. We think that somewhere between 175 to 200 mountain bikers visit the Gunsight Pass/Standard Mine/Scarps Ridge area in a summer. If there was a more defined route from the top of Gunsight through the Standard Mine site down Elk Creek to Kebler the area would probably see more use. I think many folks believe there are private property issues through the area.

APPENDIX E

ProUCL Results

This page intentionally left blank to facilitate double-sided printing.

Data File **Arsenic** **Soil**   Variable: 14

Raw Statistics

Number of Valid Samples	190
Number of Unique Samples	160
Minimum	4.6
Maximum	680
Mean	75.53368
Median	29.9
Standard Deviation	105.7539
Variance	11183.88
Coefficient of Variation	1.400089
Skewness	2.756931

Gamma Statistics

k hat	0.761712
k star (bias corrected)	0.753194
Theta hat	99.16303
Theta star	100.2845
nu hat	289.4506
nu star	286.2137
Approx.Chi Square Value (.05)	248.0214
Adjusted Level of Significance	0.048737
Adjusted Chi Square Value	247.7525

Log-transformed Statistics

Minimum of log data	1.526056
Maximum of log data	6.522093
Mean of log data	3.540317
Standard Deviation of log data	1.253373
Variance of log data	1.570943

RECOMMENDATION

Data are Non-parametric (0.05)

Use 97.5% Chebyshev (Mean, Sd) UCL

Normal Distribution Test

Lilliefors Test Statisitic	0.251192
Lilliefors 5% Critical Value	0.064277

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	88.21548

Gamma Distribution Test

A-D Test Statistic	6.992918
A-D 5% Critical Value	0.795518
K-S Test Statistic	0.15362
K-S 5% Critical Value	0.068849

Data do not follow gamma distribution at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	87.16495
Adjusted Gamma UCL	87.25957

Lognormal Distribution Test

Lilliefors Test Statisitic	0.131067
Lilliefors 5% Critical Value	0.064277

Data not lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	93.89511
95% Chebyshev (MVUE) UCL	114.1092
97.5% Chebyshev (MVUE) UCL	130.9992
99% Chebyshev (MVUE) UCL	164.1763

95% Non-parametric UCLs

CLT UCL	88.15332
Adj-CLT UCL (Adjusted for skewness)	89.79296
Mod-t UCL (Adjusted for skewness)	88.47123
Jackknife UCL	88.21548
Standard Bootstrap UCL	88.09772
Bootstrap-t UCL	90.52036
Hall's Bootstrap UCL	89.91361
Percentile Bootstrap UCL	88.19
BCA Bootstrap UCL	90.12421
95% Chebyshev (Mean, Sd) UCL	108.976
97.5% Chebyshev (Mean, Sd) UCL	123.4465
99% Chebyshev (Mean, Sd) UCL	151.871

```
Data File   Aluminum   Soil                        Variable:        7530

        Raw Statistics                                      Normal Distribution Test
Number of Valid Samples                 190   Lilliefors Test Statisitic               0.051111
Number of Unique Samples                164   Lilliefors 5% Critical Value             0.064277
Minimum                                 966   Data are normal at 5% significance level
Maximum                               18000
Mean                               7068.032      95% UCL (Assuming Normal Distribution)
Median                                 6930   Student's-t UCL                          7422.684
Standard Deviation                 2957.458
Variance                            8746558            Gamma Distribution Test
Coefficient of Variation           0.418427   A-D Test Statistic                       1.038758
Skewness                           0.400131   A-D 5% Critical Value                    0.755909
                                              K-S Test Statistic                       0.065793
        Gamma Statistics                      K-S 5% Critical Value                    0.066379
k hat                              4.939137   Data follow approximate gamma distibution
k star (bias corrected)             4.86466   at 5% significance level
Theta hat                          1431.026
Theta star                         1452.934    95% UCLs (Assuming Gamma Distribution)
nu hat                             1876.872   Approximate Gamma UCL                    7467.487
nu star                            1848.571   Adjusted Gamma UCL                       7470.584
Approx.Chi Square Value (.05)      1749.686
Adjusted Level of Significance     0.048737           Lognormal Distribution Test
Adjusted Chi Square Value           1748.96   Lilliefors Test Statisitic               0.097021
                                              Lilliefors 5% Critical Value             0.064277
     Log-transformed Statistics               Data not lognormal at 5% significance level
Minimum of log data                6.873164
Maximum of log data                9.798127     95% UCLs (Assuming Lognormal Distribution)
Mean of log data                   8.758703   95% H-UCL                                7678.868
Standard Deviation of log data     0.495221   95% Chebyshev (MVUE) UCL                  8381.19
Variance of log data               0.245244   97.5% Chebyshev (MVUE) UCL               8896.136
                                              99% Chebyshev (MVUE) UCL                 9907.647

                                                    95% Non-parametric UCLs
                                              CLT UCL                                  7420.946
                                              Adj-CLT UCL (Adjusted for skewness)      7427.601
                                              Mod-t UCL (Adjusted for skewness)        7423.722
                                              Jackknife UCL                            7422.684
                                              Standard Bootstrap UCL                   7413.029
                                              Bootstrap-t UCL                          7426.366
          RECOMMENDATION                      Hall's Bootstrap UCL                     7432.871
        Data are normal (0.05)                Percentile Bootstrap UCL                 7427.737
                                              BCA Bootstrap UCL                        7420.947
    Use Student's-t UCL                       95% Chebyshev (Mean, Sd) UCL             8003.262
                                              97.5% Chebyshev (Mean, Sd) UCL           8407.937
                                              99% Chebyshev (Mean, Sd) UCL             9202.842
```

Data File **Cadmium Soil** Variable: 5.5

Raw Statistics

Number of Valid Samples	190
Number of Unique Samples	108
Minimum	0.025
Maximum	107
Mean	7.287789
Median	2.8
Standard Deviation	13.11218
Variance	171.9293
Coefficient of Variation	1.799198
Skewness	3.95383

Gamma Statistics

k hat	0.623468
k star (bias corrected)	0.617133
Theta hat	11.68911
Theta star	11.80911
nu hat	236.9179
nu star	234.5104
Approx.Chi Square Value (.05)	200.0538
Adjusted Level of Significance	0.048737
Adjusted Chi Square Value	199.8129

Log-transformed Statistics

Minimum of log data	-3.688879
Maximum of log data	4.672829
Mean of log data	1.000729
Standard Deviation of log data	1.501054
Variance of log data	2.253162

RECOMMENDATION
Data are Non-parametric (0.05)

Use 97.5% Chebyshev (Mean, Sd) UCL

Normal Distribution Test

Lilliefors Test Statisitic	0.289825
Lilliefors 5% Critical Value	0.064277

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	8.860176

Gamma Distribution Test

A-D Test Statistic	5.385099
A-D 5% Critical Value	0.808532
K-S Test Statistic	0.149546
K-S 5% Critical Value	0.069473

Data do not follow gamma distribution
at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	8.543016
Adjusted Gamma UCL	8.553316

Lognormal Distribution Test

Lilliefors Test Statisitic	0.070083
Lilliefors 5% Critical Value	0.064277

Data not lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	11.1689
95% Chebyshev (MVUE) UCL	13.87114
97.5% Chebyshev (MVUE) UCL	16.28663
99% Chebyshev (MVUE) UCL	21.03138

95% Non-parametric UCLs

CLT UCL	8.852469
Adj-CLT UCL (Adjusted for skewness)	9.144023
Mod-t UCL (Adjusted for skewness)	8.905652
Jackknife UCL	8.860176
Standard Bootstrap UCL	8.865792
Bootstrap-t UCL	9.232408
Hall's Bootstrap UCL	9.488261
Percentile Bootstrap UCL	8.890579
BCA Bootstrap UCL	9.165763
95% Chebyshev (Mean, Sd) UCL	11.43422
97.5% Chebyshev (Mean, Sd) UCL	13.22839
99% Chebyshev (Mean, Sd) UCL	16.75268

Data File **Chromium Soil** Variable: 4.6

Raw Statistics

Number of Valid Samples	190
Number of Unique Samples	86
Minimum	0.71
Maximum	93.2
Mean	6.941632
Median	5.75
Standard Deviation	8.2271
Variance	67.68517
Coefficient of Variation	1.185182
Skewness	7.705377

Gamma Statistics

k hat	2.445255
k star (bias corrected)	2.410155
Theta hat	2.838817
Theta star	2.88016
nu hat	929.197
nu star	915.8588
Approx.Chi Square Value (.05)	846.6021
Adjusted Level of Significance	0.048737
Adjusted Chi Square Value	846.0996

Log-transformed Statistics

Minimum of log data	-0.34249
Maximum of log data	4.534748
Mean of log data	1.719339
Standard Deviation of log data	0.584762
Variance of log data	0.341947

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test

Lilliefors Test Statisitic	0.307053
Lilliefors 5% Critical Value	0.064277

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	7.928209

Gamma Distribution Test

A-D Test Statistic	8.039347
A-D 5% Critical Value	0.763563
K-S Test Statistic	0.177043
K-S 5% Critical Value	0.066902

Data do not follow gamma distribution
at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	7.509495
Adjusted Gamma UCL	7.513955

Lognormal Distribution Test

Lilliefors Test Statisitic	0.117064
Lilliefors 5% Critical Value	0.064277

Data not lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	7.163697
95% Chebyshev (MVUE) UCL	7.933186
97.5% Chebyshev (MVUE) UCL	8.50379
99% Chebyshev (MVUE) UCL	9.624632

95% Non-parametric UCLs

CLT UCL	7.923373
Adj-CLT UCL (Adjusted for skewness)	8.27988
Mod-t UCL (Adjusted for skewness)	7.983817
Jackknife UCL	7.928209
Standard Bootstrap UCL	7.929028
Bootstrap-t UCL	8.919318
Hall's Bootstrap UCL	12.5619
Percentile Bootstrap UCL	8.026947
BCA Bootstrap UCL	8.389105
95% Chebyshev (Mean, Sd) UCL	9.543269
97.5% Chebyshev (Mean, Sd) UCL	10.669
99% Chebyshev (Mean, Sd) UCL	12.88028

Data File **Iron** **Soil**

Variable: 13700

Raw Statistics

Number of Valid Samples	190
Number of Unique Samples	157
Minimum	5600
Maximum	195999
Mean	32634.88
Median	21300
Standard Deviation	28348.01
Variance	8.04E+08
Coefficient of Variation	0.868641
Skewness	2.23622

Gamma Statistics

k hat	1.886921
k star (bias corrected)	1.860636
Theta hat	17295.31
Theta star	17539.63
nu hat	717.03
nu star	707.0418
Approx.Chi Square Value (.05)	646.3333
Adjusted Level of Significance	0.048737
Adjusted Chi Square Value	645.8951

Log-transformed Statistics

Minimum of log data	8.630522
Maximum of log data	12.18586
Mean of log data	10.10534
Standard Deviation of log data	0.735825
Variance of log data	0.541439

RECOMMENDATION

Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test

Lilliefors Test Statisitic	0.173733
Lilliefors 5% Critical Value	0.064277

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	36034.32

Gamma Distribution Test

A-D Test Statistic	5.073575
A-D 5% Critical Value	0.767385
K-S Test Statistic	0.139134
K-S 5% Critical Value	0.06718

Data do not follow gamma distribution at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	35700.19
Adjusted Gamma UCL	35724.42

Lognormal Distribution Test

Lilliefors Test Statisitic	0.120621
Lilliefors 5% Critical Value	0.064277

Data not lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	35604.26
95% Chebyshev (MVUE) UCL	40374.71
97.5% Chebyshev (MVUE) UCL	43987.89
99% Chebyshev (MVUE) UCL	51085.29

95% Non-parametric UCLs

CLT UCL	36017.65
Adj-CLT UCL (Adjusted for skewness)	36374.16
Mod-t UCL (Adjusted for skewness)	36089.92
Jackknife UCL	36034.32
Standard Bootstrap UCL	35998.89
Bootstrap-t UCL	36474.68
Hall's Bootstrap UCL	36723.03
Percentile Bootstrap UCL	36086.97
BCA Bootstrap UCL	36411.72
95% Chebyshev (Mean, Sd) UCL	41599.31
97.5% Chebyshev (Mean, Sd) UCL	45478.22
99% Chebyshev (Mean, Sd) UCL	53097.6

Data File **Manganese** **Soil** Variable: 2770

Raw Statistics

Number of Valid Samples	190
Number of Unique Samples	157
Minimum	185
Maximum	12200
Mean	2247.805
Median	1610
Standard Deviation	2025.653
Variance	4103270
Coefficient of Variation	0.901169
Skewness	2.296064

Gamma Statistics

k hat	1.846414
k star (bias corrected)	1.820769
Theta hat	1217.39
Theta star	1234.536
nu hat	701.6373
nu star	691.8921
Approx.Chi Square Value (.05)	631.8502
Adjusted Level of Significance	0.048737
Adjusted Chi Square Value	631.417

Log-transformed Statistics

Minimum of log data	5.220356
Maximum of log data	9.409191
Mean of log data	7.423109
Standard Deviation of log data	0.754508
Variance of log data	0.569282

RECOMMENDATION
Data are Non-parametric (0.05)

Use 95% Chebyshev (Mean, Sd) UCL

Normal Distribution Test

Lilliefors Test Statisitic	0.226408
Lilliefors 5% Critical Value	0.064277

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	2490.717

Gamma Distribution Test

A-D Test Statistic	4.218226
A-D 5% Critical Value	0.767784
K-S Test Statistic	0.136803
K-S 5% Critical Value	0.06721

Data do not follow gamma distribution at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	2461.404
Adjusted Gamma UCL	2463.093

Lognormal Distribution Test

Lilliefors Test Statisitic	0.081202
Lilliefors 5% Critical Value	0.064277

Data not lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	2478.152
95% Chebyshev (MVUE) UCL	2818.22
97.5% Chebyshev (MVUE) UCL	3076.522
99% Chebyshev (MVUE) UCL	3583.905

95% Non-parametric UCLs

CLT UCL	2489.527
Adj-CLT UCL (Adjusted for skewness)	2515.683
Mod-t UCL (Adjusted for skewness)	2494.797
Jackknife UCL	2490.717
Standard Bootstrap UCL	2485.369
Bootstrap-t UCL	2521.189
Hall's Bootstrap UCL	2525.319
Percentile Bootstrap UCL	2500.621
BCA Bootstrap UCL	2496.711
95% Chebyshev (Mean, Sd) UCL	2888.373
97.5% Chebyshev (Mean, Sd) UCL	3165.547
99% Chebyshev (Mean, Sd) UCL	3710.002

Data File **Lead** **Soil** Variable: 1780

Raw Statistics

Number of Valid Samples	190
Number of Unique Samples	181
Minimum	0.215
Maximum	63500
Mean	3638.781
Median	1405
Standard Deviation	6857.964
Variance	47031667
Coefficient of Variation	1.884687
Skewness	4.932849

Gamma Statistics

k hat	0.556557
k star (bias corrected)	0.551278
Theta hat	6538.025
Theta star	6600.633
nu hat	211.4915
nu star	209.4855
Approx.Chi Square Value (.05)	176.9856
Adjusted Level of Significance	0.048737
Adjusted Chi Square Value	176.7594

Log-transformed Statistics

Minimum of log data	-1.537117
Maximum of log data	11.0588
Mean of log data	7.076703
Standard Deviation of log data	1.689124
Variance of log data	2.853138

RECOMMENDATION

Data are lognormal (0.05)

Use H-UCL

Normal Distribution Test

Lilliefors Test Statisitic	0.297862
Lilliefors 5% Critical Value	0.064277

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	4461.174

Gamma Distribution Test

A-D Test Statistic	2.795579
A-D 5% Critical Value	0.81511
K-S Test Statistic	0.101717
K-S 5% Critical Value	0.069785

Data do not follow gamma distribution
at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	4306.972
Adjusted Gamma UCL	4312.484

Lognormal Distribution Test

Lilliefors Test Statisitic	0.052014
Lilliefors 5% Critical Value	0.064277

Data are lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	6968.576
95% Chebyshev (MVUE) UCL	8732.483
97.5% Chebyshev (MVUE) UCL	10415.19
99% Chebyshev (MVUE) UCL	13720.54

95% Non-parametric UCLs

CLT UCL	4457.143
Adj-CLT UCL (Adjusted for skewness)	4647.391
Mod-t UCL (Adjusted for skewness)	4490.849
Jackknife UCL	4461.174
Standard Bootstrap UCL	4451.49
Bootstrap-t UCL	4801.696
Hall's Bootstrap UCL	4895.209
Percentile Bootstrap UCL	4473.308
BCA Bootstrap UCL	4764.854
95% Chebyshev (Mean, Sd) UCL	5807.46
97.5% Chebyshev (Mean, Sd) UCL	6745.849
99% Chebyshev (Mean, Sd) UCL	8589.132

Data File **Arsenic** **Sediment-Drainage** Variable: 50.7

Raw Statistics

Number of Valid Samples	37
Number of Unique Samples	37
Minimum	13.2
Maximum	178
Mean	68.46486
Median	65.9
Standard Deviation	40.91583
Variance	1674.105
Coefficient of Variation	0.597618
Skewness	1.189744

Gamma Statistics

k hat	3.044638
k star (bias corrected)	2.815794
Theta hat	22.48703
Theta star	24.31459
nu hat	225.3032
nu star	208.3687
Approx.Chi Square Value (.05)	175.9588
Adjusted Level of Significance	0.0431
Adjusted Chi Square Value	174.6685

Log-transformed Statistics

Minimum of log data	2.580217
Maximum of log data	5.181784
Mean of log data	4.0532
Standard Deviation of log data	0.616268
Variance of log data	0.379786

RECOMMENDATION

Data follow gamma distribution (0.05)

Use Approximate Gamma UCL

Normal Distribution Test

Shapiro-Wilk Test Statisitic	0.883761
Shapiro-Wilk 5% Critical Value	0.936

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	79.82123

Gamma Distribution Test

A-D Test Statistic	0.360594
A-D 5% Critical Value	0.754017
K-S Test Statistic	0.102117
K-S 5% Critical Value	0.145957

Data follow gamma distribution
at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	81.07545
Adjusted Gamma UCL	81.67437

Lognormal Distribution Test

Shapiro-Wilk Test Statisitic	0.969384
Shapiro-Wilk 5% Critical Value	0.936

Data are lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	85.53923
95% Chebyshev (MVUE) UCL	101.887
97.5% Chebyshev (MVUE) UCL	116.0285
99% Chebyshev (MVUE) UCL	143.8068

95% Non-parametric UCLs

CLT UCL	79.52901
Adj-CLT UCL (Adjusted for skewness)	80.93481
Mod-t UCL (Adjusted for skewness)	80.04051
Jackknife UCL	79.82123
Standard Bootstrap UCL	79.39323
Bootstrap-t UCL	81.55319
Hall's Bootstrap UCL	81.88495
Percentile Bootstrap UCL	79.85135
BCA Bootstrap UCL	81.45946
95% Chebyshev (Mean, Sd) UCL	97.78509
97.5% Chebyshev (Mean, Sd) UCL	110.472
99% Chebyshev (Mean, Sd) UCL	135.3929

```
Data File   Arsenic    Fish - Drainage                      Variable:        0.161

            Raw Statistics                                    Normal Distribution Test
Number of Valid Samples                  13    Shapiro-Wilk Test Statisitic              0.698226
Number of Unique Samples                 13    Shapiro-Wilk 5% Critical Value               0.866
Minimum                               0.161    Data not normal at 5% significance level
Maximum                              3.1995
Mean                               0.915285        95% UCL (Assuming Normal Distribution)
Median                               0.3315    Student's-t UCL                           1.469264
Standard Deviation                 1.120696
Variance                           1.255959              Gamma Distribution Test
Coefficient of Variation           1.224423    A-D Test Statistic                         1.15955
Skewness                            1.40332    A-D 5% Critical Value                     0.761724
                                               K-S Test Statistic                        0.261687
          Gamma Statistics                     K-S 5% Critical Value                     0.243981
k hat                              0.916266    Data do not follow gamma distribution
k star (bias corrected)            0.756102    at 5% significance level
Theta hat                          0.998929
Theta star                         1.210531     95% UCLs (Assuming Gamma Distribution)
nu hat                             23.82291    Approximate Gamma UCL                     1.697731
nu star                            19.65865    Adjusted Gamma UCL                         1.86219
Approx.Chi Square Value (.05)      10.59842
Adjusted Level of Significance      0.03009             Lognormal Distribution Test
Adjusted Chi Square Value          9.662416    Shapiro-Wilk Test Statisitic              0.842622
                                               Shapiro-Wilk 5% Critical Value               0.866
     Log-transformed Statistics                Data not lognormal at 5% significance level
Minimum of log data               -1.826351
Maximum of log data                1.162995      95% UCLs (Assuming Lognormal Distribution)
Mean of log data                  -0.725144    95% H-UCL                                 2.496102
Standard Deviation of log data     1.127581    95% Chebyshev (MVUE) UCL                  2.116362
Variance of log data               1.271439    97.5% Chebyshev (MVUE) UCL                2.663678
                                               99% Chebyshev (MVUE) UCL                  3.738776

                                                     95% Non-parametric UCLs
                                               CLT UCL                                   1.426546
                                               Adj-CLT UCL (Adjusted for skewness)       1.555811
                                               Mod-t UCL (Adjusted for skewness)         1.489427
                                               Jackknife UCL                             1.469264
                                               Standard Bootstrap UCL                    1.409876
                                               Bootstrap-t UCL                           1.735916
          RECOMMENDATION                       Hall's Bootstrap UCL                       1.36371
    Data are Non-parametric (0.05)             Percentile Bootstrap UCL                  1.448438
                                               BCA Bootstrap UCL                         1.554623
   Use 99% Chebyshev (Mean, Sd) UCL            95% Chebyshev (Mean, Sd) UCL               2.27014
                                               97.5% Chebyshev (Mean, Sd) UCL            2.856386
                                               99% Chebyshev (Mean, Sd) UCL              4.007955
Recommended UCL exceeds the maximum observation
Consider using 95% or 97.5% Chebyshev (Mean, Sd) UCL
```

Data File **Arsenic** **SW-Drainage** Variable: 7.38

Raw Statistics

Number of Valid Samples	94
Number of Unique Samples	57
Minimum	0.014
Maximum	10.3
Mean	2.659872
Median	2.45
Standard Deviation	2.049808
Variance	4.201712
Coefficient of Variation	0.770641
Skewness	1.128858

Gamma Statistics

k hat	1.209814
k star (bias corrected)	1.178295
Theta hat	2.19858
Theta star	2.257391
nu hat	227.4449
nu star	221.5194
Approx.Chi Square Value (.05)	188.0647
Adjusted Level of Significance	0.047447
Adjusted Chi Square Value	187.5882

Log-transformed Statistics

Minimum of log data	-4.268698
Maximum of log data	2.332144
Mean of log data	0.511139
Standard Deviation of log data	1.289515
Variance of log data	1.662849

RECOMMENDATION
Data are Non-parametric (0.05)

Use 97.5% Chebyshev (Mean, Sd) UCL

Normal Distribution Test

Lilliefors Test Statisitic	0.190658
Lilliefors 5% Critical Value	0.091384

Data not normal at 5% significance level

95% UCL (Assuming Normal Distribution)

Student's-t UCL	3.011129

Gamma Distribution Test

A-D Test Statistic	1.639297
A-D 5% Critical Value	0.777808
K-S Test Statistic	0.1455
K-S 5% Critical Value	0.094618

Data do not follow gamma distribution at 5% significance level

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	3.133035
Adjusted Gamma UCL	3.140994

Lognormal Distribution Test

Lilliefors Test Statisitic	0.20455
Lilliefors 5% Critical Value	0.091384

Data not lognormal at 5% significance level

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	5.349093
95% Chebyshev (MVUE) UCL	6.6143
97.5% Chebyshev (MVUE) UCL	7.845558
99% Chebyshev (MVUE) UCL	10.26413

95% Non-parametric UCLs

CLT UCL	3.00763
Adj-CLT UCL (Adjusted for skewness)	3.033933
Mod-t UCL (Adjusted for skewness)	3.015232
Jackknife UCL	3.011129
Standard Bootstrap UCL	3.008654
Bootstrap-t UCL	3.040095
Hall's Bootstrap UCL	3.016455
Percentile Bootstrap UCL	3.011298
BCA Bootstrap UCL	3.037649
95% Chebyshev (Mean, Sd) UCL	3.581437
97.5% Chebyshev (Mean, Sd) UCL	3.980199
99% Chebyshev (Mean, Sd) UCL	4.76349

```
Data File   Cadmium  SW-Drainage                    Variable:        0.5

         Raw Statistics                                  Normal Distribution Test
Number of Valid Samples                101    Lilliefors Test Statisitic                 0.35385
Number of Unique Samples                56    Lilliefors 5% Critical Value               0.08816
Minimum                                0.2    Data not normal at 5% significance level
Maximum                               61.1
Mean                              2.713327       95% UCL (Assuming Normal Distribution)
Median                                0.64    Student's-t UCL                           3.820685
Standard Deviation                6.703159
Variance                          44.93234            Gamma Distribution Test
Coefficient of Variation          2.470458    A-D Test Statistic                        8.753767
Skewness                          7.024772    A-D 5% Critical Value                     0.801096
                                              K-S Test Statistic                        0.231285
          Gamma Statistics                    K-S 5% Critical Value                     0.093103
k hat                             0.685328    Data do not follow gamma distribution
k star (bias corrected)           0.671572    at 5% significance level
Theta hat                         3.959166
Theta star                         4.04026     95% UCLs (Assuming Gamma Distribution)
nu hat                            138.4362    Approximate Gamma UCL                     3.354056
nu star                           135.6576    Adjusted Gamma UCL                        3.364339
Approx.Chi Square Value (.05)     109.7428
Adjusted Level of Significance    0.047624           Lognormal Distribution Test
Adjusted Chi Square Value         109.4074    Lilliefors Test Statisitic                0.206423
                                              Lilliefors 5% Critical Value               0.08816
      Log-transformed Statistics              Data not lognormal at 5% significance level
Minimum of log data              -1.609438
Maximum of log data               4.112512      95% UCLs (Assuming Lognormal Distribution)
Mean of log data                  0.113722    95% H-UCL                                 2.791783
Standard Deviation of log data     1.13783    95% Chebyshev (MVUE) UCL                  3.423922
Variance of log data              1.294657    97.5% Chebyshev (MVUE) UCL                3.988806
                                              99% Chebyshev (MVUE) UCL                  5.098412

                                                      95% Non-parametric UCLs
                                              CLT UCL                                   3.810426
                                              Adj-CLT UCL (Adjusted for skewness)       4.308589
                                              Mod-t UCL (Adjusted for skewness)         3.898388
                                              Jackknife UCL                             3.820685
                                              Standard Bootstrap UCL                    3.773178
                                              Bootstrap-t UCL                           5.096101
         RECOMMENDATION                       Hall's Bootstrap UCL                      8.055859
    Data are Non-parametric (0.05)            Percentile Bootstrap UCL                  3.871238
                                              BCA Bootstrap UCL                         4.536059
  Use 97.5% Chebyshev (Mean, Sd) UCL          95% Chebyshev (Mean, Sd) UCL              5.620665
                                              97.5% Chebyshev (Mean, Sd) UCL            6.878673
                                              99% Chebyshev (Mean, Sd) UCL              9.349786
```

APPENDIX F

DERIVATION OF PARTICULATE EMISSION FACTOR FOR ATV RIDING

APPENDIX F

DERIVATION OF PARTICULATE EMISSION FACTOR FOR ATV RIDING

1.0 INTRODUCTION

One pathway that humans may be exposed to contaminants in soil is by inhalation of particles of soil that become re-suspended in air. When reliable site-specific measurements of contaminant levels in air due to re-suspended soil particles are not available, the concentration of contaminants may be estimated as follows (USEPA 1996, 2002):

$$C_{air} = C_{soil} \bullet PEF$$

where:

C_{air} = Concentration of contaminant in air (mg/m^3)
C_{soil} = Concentration of contaminant in soil (mg/kg)
PEF = Soil to air emission factor (kg/m^3)

Note the PEF term in this equation is the inverse of the value presented in USEPA (1996, 2002), which has units of m^3/kg.

The value of PEF depends on a number of site-specific factors, as well as the nature of the force (wind, mechanical disturbance) that leads to soil particle re-suspension in air. The following sections present the derivation of the PEF values used to estimate contaminant concentrations in air from the re-suspension of soil attributable to ATV riding (PEF_{atv}).

2.0 ESTIMATION OF THE PEF FOR ALL TERRAIN VEHICLE RIDING (PEF_{atv})

A PEF value for riding All Terrain Vehicles (ATVs) was derived from empirical data. USEPA (Brass, 2006) collected measurements of total dust in air during use of 2 ATVs at the Quincy Smelter site California during August 2004. A Thermo Electron DataRam was attached to the front rack of the tailing ATV and measurements of total dust, temperature and humidity were collected over a 6 hour period. The total dust measurements are presented electronically in Attachment 1. Concentrations of dust in air varied considerably during the 6 hour period, from a minimum concentration of 18.7 ug/m^3 to a maximum concentration of 23,359 ug/m^3. Several factors are likely to influence the wide range of observed concentrations, including: variation in speed, position of the ATVs relative to one another (directly behind, perpendicular, etc.) and distance between the vehicles.

From these data, a PEF for ATV riding was estimated by taking the mean concentration of dust in air generated during ATV use and multiplying by the fraction of total dust that is respirable to estimate the PM10 generated during dirt bike riding. This calculation is as follows:

$$PEF_{atv} = C_{Total\,Dust} \cdot f_{PM10} \cdot CF$$

where:

PEF_{atv} = Particulate emission factor for ATV riding (kg/m^3)
f_{PM10} = Fraction of total dust that is PM$_{10}$ (unitless)
$C_{Total\,Dust}$ = Concentration of total dust (ug/m^3)
CF = Conversion Factor (kg/ug)

The assumptions for evaluating emissions from ATV riding are summarized in Table F-1. Based on these parameters, the PEF for release of soil particles into air due to ATV riding is 1.18E-06 kg/m^3.

3.0 REFERENCES

Brass B. 2006. Personal Communication. USEPA/ERT-West. Las Vegas, Nevada. January.

United States Environmental Protection Agency (USEPA). 1996. U.S. Environmental Protection Agency. Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response, Washington, D.C. EPA/540/R-95/128. May.

United States Environmental Protection Agency (USEPA). 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. December.

TABLE F-1
PARAMETERS USED TO CALCULATE PEF FOR ATV RIDING

Parameter	Parameter Definition	Value	Units	Source	Notes
f_{PM10}	Fraction of total dust that is PM10	0.35	unitless	USEPA 2006a	Professional judgment, based on characteristics of sensing technology, field observations, sieve analysis, and aggressive nature of the soil disturbance.
$C_{Total\ Dust}$	Concentration of total dust in air during ATV riding	3.4E+03	ug/m^3	USEPA 2006b	Mean total dust concentration in air over a six hour riding period.
CF	Conversion Factor	1E-09	kg/ug	--	--

References:

USEPA (2006a). Personal communication with Brian Brass, USEPA/ERT-West. January.

USEPA (2006b). Data provided by Brian Brass. See attachment 1.

ATTACHMENT 1.
RAW DATA COLLECTED DURING ATV RIDING AT THE QUINCY SMELTER SITE

(see *DATARAM.xls* file on attached CD)

APPENDIX G

DETAILED RISK CALCULATIONS FOR NON-LEAD COPCs

Table G-1
Detailed Risk Calculation Tables for Adult ATV Riders at the Mine Site

CTE Scenario

Inhalation Caused by Human Disturbance

					Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	PEF (kg/m^3)	Cair (mg/m^3)	HIFNC (kg/kg-d)	DI (mg/kg-d)	RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	SF (mg/kg-d)-	Risk
Aluminum	7.42E+03	1.0	1.18E-06	8.76E-03	8.45E-04	7.4E-06	1.00E-03	7E-03	1.09E-04	9.5E-07	--	NA
Arsenic	1.23E+02	1.0	1.18E-06	1.46E-04	8.45E-04	1.2E-07	--	NA	1.09E-04	1.6E-08	1.51E+01	2E-07
Cadmium	1.32E+01	1.0	1.18E-06	1.56E-05	8.45E-04	1.3E-08	5.70E-05	2E-04	1.09E-04	1.7E-09	6.30E+00	1E-08
Chromium	9.54E+00	1.0	1.18E-06	1.13E-05	8.45E-04	9.5E-09	3.00E-05	3E-04	1.09E-04	1.2E-09	4.10E+01	5E-08
Iron	4.16E+04	1.0	1.18E-06	4.91E-02	8.45E-04	4.1E-05	--	NA	1.09E-04	5.3E-06	--	NA
Manganese	2.89E+03	1.0	1.18E-06	3.41E-03	8.45E-04	2.9E-06	1.43E-05	2E-01	1.09E-04	3.7E-07	--	NA

Incidental Ingestion of Soil

			Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF (mg/kg-d)$^{-1}$	Risk
Aluminum	7.42E+03	1.0	1.17E-08	8.7E-05	1.00E+00	9E-05	1.51E-09	1.1E-05	--	NA
Arsenic	1.23E+02	0.5	1.17E-08	7.2E-07	3.00E-04	2E-03	1.51E-09	9.3E-08	1.50E+00	1E-07
Cadmium	1.32E+01	1.0	1.17E-08	1.6E-07	1.00E-03	2E-04	1.51E-09	2.0E-08	--	NA
Chromium	9.54E+00	1.0	1.17E-08	1.1E-07	3.00E-03	4E-05	1.51E-09	1.4E-08	--	NA
Iron	4.16E+04	1.0	1.17E-08	4.9E-04	3.00E-01	2E-03	1.51E-09	6.3E-05	--	NA
Manganese	2.89E+03	1.0	1.17E-08	3.4E-05	4.67E-02	7E-04	1.51E-09	4.4E-06	--	NA

RME Scenario

Inhalation Caused by Human Disturbance

					Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	PEF (kg/m^3)	Cair (mg/m^3)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Inhalation RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Inhalation SF (mg/kg-d)-	Risk
Aluminum	7.42E+03	1.0	1.18E-06	8.76E-03	4.70E-03	4.1E-05	1.00E-03	4E-02	2.01E-03	1.8E-05	--	NA
Arsenic	1.23E+02	1.0	1.18E-06	1.46E-04	4.70E-03	6.8E-07	--	NA	2.01E-03	2.9E-07	1.51E+01	4E-06
Cadmium	1.32E+01	1.0	1.18E-06	1.56E-05	4.70E-03	7.3E-08	5.70E-05	1E-03	2.01E-03	3.1E-08	6.30E+00	2E-07
Chromium	9.54E+00	1.0	1.18E-06	1.13E-05	4.70E-03	5.3E-08	3.00E-05	2E-03	2.01E-03	2.3E-08	4.10E+01	9E-07
Iron	4.16E+04	1.0	1.18E-06	4.91E-02	4.70E-03	2.3E-04	--	NA	2.01E-03	9.9E-05	--	NA
Manganese	2.89E+03	1.0	1.18E-06	3.41E-03	4.70E-03	1.6E-05	1.43E-05	1E+00	2.01E-03	6.9E-06	--	NA

Incidental Ingestion of Soil

			Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF (mg/kg-d)$^{-1}$	Risk
Aluminum	7.42E+03	1.0	7.83E-08	5.8E-04	1.00E+00	6E-04	3.35E-08	2.5E-04	--	NA
Arsenic	1.23E+02	0.5	7.83E-08	4.8E-06	3.00E-04	2E-02	3.35E-08	2.1E-06	1.50E+00	3E-06
Cadmium	1.32E+01	1.0	7.83E-08	1.0E-06	1.00E-03	1E-03	3.35E-08	4.4E-07	--	NA
Chromium	9.54E+00	1.0	7.83E-08	7.5E-07	3.00E-03	2E-04	3.35E-08	3.2E-07	--	NA
Iron	4.16E+04	1.0	7.83E-08	3.3E-03	3.00E-01	1E-02	3.35E-08	1.4E-03	--	NA
Manganese	2.89E+03	1.0	7.83E-08	2.3E-04	4.67E-02	5E-03	3.35E-08	9.7E-05	--	NA

Table G-2
Detailed Risk Calculation Tables for Child ATV Riders at the Mine Site

CTE Scenario

Inhalation Caused by Human Disturbance

					Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	PEF (kg/m^3)	Cair (mg/m^3)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Inhalation RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Inhalation SF (mg/kg-d)-1	Risk
Aluminum	7.42E+03	1.0	1.18E-06	8.76E-03	1.16E-03	1.0E-05	1.00E-03	1E-02	3.31E-05	2.9E-07	--	NA
Arsenic	1.23E+02	1.0	1.18E-06	1.46E-04	1.16E-03	1.7E-07	--	NA	3.31E-05	4.8E-09	1.51E+01	7E-08
Cadmium	1.32E+01	1.0	1.18E-06	1.56E-05	1.16E-03	1.8E-08	5.70E-05	3E-04	3.31E-05	5.2E-10	6.30E+00	3E-09
Chromium	9.54E+00	1.0	1.18E-06	1.13E-05	1.16E-03	1.3E-08	3.00E-05	4E-04	3.31E-05	3.7E-10	4.10E+01	2E-08
Iron	4.16E+04	1.0	1.18E-06	4.91E-02	1.16E-03	5.7E-05	--	NA	3.31E-05	1.6E-06	--	NA
Manganese	2.89E+03	1.0	1.18E-06	3.41E-03	1.16E-03	3.9E-06	1.43E-05	3E-01	3.31E-05	1.1E-07	--	NA

Incidental Ingestion of Soil

			Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF (mg/kg-d)$^{-1}$	Risk
Aluminum	7.42E+03	1.0	4.98E-08	3.7E-04	1.00E+00	4E-04	1.42E-09	1.1E-05	--	NA
Arsenic	1.23E+02	0.5	4.98E-08	3.1E-06	3.00E-04	1E-02	1.42E-09	8.8E-08	1.50E+00	1E-07
Cadmium	1.32E+01	1.0	4.98E-08	6.6E-07	1.00E-03	7E-04	1.42E-09	1.9E-08	--	NA
Chromium	9.54E+00	1.0	4.98E-08	4.8E-07	3.00E-03	2E-04	1.42E-09	1.4E-08	--	NA
Iron	4.16E+04	1.0	4.98E-08	2.1E-03	3.00E-01	7E-03	1.42E-09	5.9E-05	--	NA
Manganese	2.89E+03	1.0	4.98E-08	1.4E-04	4.67E-02	3E-03	1.42E-09	4.1E-06	--	NA

RME Scenario

Inhalation Caused by Human Disturbance

					Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	PEF (kg/m^3)	Cair (mg/m^3)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Inhalation RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Inhalation SF (mg/kg-d)-1	Risk
Aluminum	7.42E+03	1.0	1.18E-06	8.76E-03	6.43E-03	5.6E-05	1.00E-03	6E-02	5.52E-04	4.8E-06	--	NA
Arsenic	1.23E+02	1.0	1.18E-06	1.46E-04	6.43E-03	9.4E-07	--	NA	5.52E-04	8.0E-08	1.51E+01	1E-06
Cadmium	1.32E+01	1.0	1.18E-06	1.56E-05	6.43E-03	1.0E-07	5.70E-05	2E-03	5.52E-04	8.6E-09	6.30E+00	5E-08
Chromium	9.54E+00	1.0	1.18E-06	1.13E-05	6.43E-03	7.2E-08	3.00E-05	2E-03	5.52E-04	6.2E-09	4.10E+01	3E-07
Iron	4.16E+04	1.0	1.18E-06	4.91E-02	6.43E-03	3.2E-04	--	NA	5.52E-04	2.7E-05	--	NA
Manganese	2.89E+03	1.0	1.18E-06	3.41E-03	6.43E-03	2.2E-05	1.43E-05	2E+00	5.52E-04	1.9E-06	--	NA

Incidental Ingestion of Soil

			Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF (mg/kg-d)$^{-1}$	Risk
Aluminum	7.42E+03	1.0	3.32E-07	2.5E-03	1.00E+00	2E-03	2.85E-08	2.1E-04	--	NA
Arsenic	1.23E+02	0.5	3.32E-07	2.0E-05	3.00E-04	7E-02	2.85E-08	1.8E-06	1.50E+00	3E-06
Cadmium	1.32E+01	1.0	3.32E-07	4.4E-06	1.00E-03	4E-03	2.85E-08	3.8E-07	--	NA
Chromium	9.54E+00	1.0	3.32E-07	3.2E-06	3.00E-03	1E-03	2.85E-08	2.7E-07	--	NA
Iron	4.16E+04	1.0	3.32E-07	1.4E-02	3.00E-01	5E-02	2.85E-08	1.2E-03	--	NA
Manganese	2.89E+03	1.0	3.32E-07	9.6E-04	4.67E-02	2E-02	2.85E-08	8.2E-05	--	NA

Table G-3
Detailed Risk Calculation Tables for Adult Hikers at the Mine Site

CTE Scenario

Incidental Ingestion of Soil

			Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF (mg/kg-d)$^{-1}$	Risk
Aluminum	7.42E+03	1.0	5.87E-09	4.4E-05	1.00E+00	4E-05	7.55E-10	5.6E-06	--	NA
Arsenic	1.23E+02	0.5	5.87E-09	3.6E-07	3.00E-04	1E-03	7.55E-10	4.7E-08	1.50E+00	7E-08
Cadmium	1.32E+01	1.0	5.87E-09	7.8E-08	1.00E-03	8E-05	7.55E-10	1.0E-08	--	NA
Chromium	9.54E+00	1.0	5.87E-09	5.6E-08	3.00E-03	2E-05	7.55E-10	7.2E-09	--	NA
Iron	4.16E+04	1.0	5.87E-09	2.4E-04	3.00E-01	8E-04	7.55E-10	3.1E-05	--	NA
Manganese	2.89E+03	1.0	5.87E-09	1.7E-05	4.67E-02	4E-04	7.55E-10	2.2E-06	--	NA
Thallium	7.65E-01	1.0	5.87E-09	4.5E-09	7.00E-05	6E-05	7.55E-10	5.8E-10	--	NA

RME Scenario

Incidental Ingestion of Soil

			Non-Cancer Risk				Cancer Risk			
Analyte	Csoil (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF (mg/kg-d)$^{-1}$	Risk
Aluminum	7.42E+03	1.0	3.91E-08	2.9E-04	1.00E+00	3E-04	1.68E-08	1.2E-04	--	NA
Arsenic	1.23E+02	0.5	3.91E-08	2.4E-06	3.00E-04	8E-03	1.68E-08	1.0E-06	1.50E+00	2E-06
Cadmium	1.32E+01	1.0	3.91E-08	5.2E-07	1.00E-03	5E-04	1.68E-08	2.2E-07	--	NA
Chromium	9.54E+00	1.0	3.91E-08	3.7E-07	3.00E-03	1E-04	1.68E-08	1.6E-07	--	NA
Iron	4.16E+04	1.0	3.91E-08	1.6E-03	3.00E-01	5E-03	1.68E-08	7.0E-04	--	NA
Manganese	2.89E+03	1.0	3.91E-08	1.1E-04	4.67E-02	2E-03	1.68E-08	4.8E-05	--	NA
Thallium	7.65E-01	1.0	3.91E-08	3.0E-08	7.00E-05	4E-04	1.68E-08	1.3E-08	--	NA

Table G-4
Detailed Risk Calculation Tables for Adult Fishermen in the Drainages

CTE Scenario

Ingestion of Fish Tissue

				Non-Cancer Risk				Cancer Risk			
Analyte	Cfish (mg/kg)	RBA (unitless)	Fraction inorganic	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.20E+00	1.0	0.1	7.33E-06	2.3E-06	3.00E-04	8E-03	7.33E-06	2.3E-06	1.50E+00	4E-06

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	2.94E-09	1.2E-07	3.00E-04	4E-04	3.77E-10	1.5E-08	1.50E+00	1E-08

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	5.87E-07	2.3E-09	3.00E-04	8E-06	7.55E-08	3.0E-10	1.50E+00	2E-10
Cadmium	6.88E-03	1.0	5.87E-07	4.0E-09	5.00E-04	8E-06	7.55E-08	5.2E-10	--	NA

RME Scenario

Ingestion of Fish Tissue

				Non-Cancer Risk				Cancer Risk			
Analyte	Cfish (mg/kg)	RBA (unitless)	Fraction inorganic	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.20E+00	1.0	0.1	6.85E-05	2.2E-05	3.00E-04	7E-02	2.94E-05	9.4E-06	1.50E+00	1E-05

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	1.96E-08	8.0E-07	3.00E-04	3E-03	8.39E-09	3.4E-07	1.50E+00	2E-07

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	3.52E-05	1.4E-07	3.00E-04	5E-04	1.51E-05	6.0E-08	1.50E+00	4E-08
Cadmium	6.88E-03	1.0	3.52E-05	2.4E-07	5.00E-04	5E-04	1.51E-05	1.0E-07	--	NA

Table G-5
Detailed Risk Calculation Tables for Recreational Children in the Drainages

CTE Scenario

Ingestion of Fish Tissue

				Non-Cancer Risk				Cancer Risk			
Analyte	Cfish (mg/kg)	RBA (unitless)	Fraction inorganic	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.20E+00	1.0	0.1	7.77E-06	2.5E-06	3.00E-04	8E-03	2.22E-07	7.1E-08	1.50E+00	1E-07

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	1.25E-08	5.1E-07	3.00E-04	2E-03	3.56E-10	1.5E-08	1.50E+00	1E-08

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	1.25E-06	5.0E-09	3.00E-04	2E-05	3.56E-08	1.4E-10	1.50E+00	9E-11
Cadmium	6.88E-03	1.0	1.25E-06	8.6E-09	5.00E-04	2E-05	3.56E-08	2.4E-10	–	NA

RME Scenario

Ingestion of Fish Tissue

				Non-Cancer Risk				Cancer Risk			
Analyte	Cfish (mg/kg)	RBA (unitless)	Fraction inorganic	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.20E+00	1.0	0.1	7.26E-05	2.3E-05	3.00E-04	8E-02	6.23E-06	2.0E-06	1.50E+00	3E-06

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	8.30E-08	3.4E-06	3.00E-04	1E-02	7.12E-09	2.9E-07	1.50E+00	2E-07

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	7.47E-05	3.0E-07	3.00E-04	1E-03	6.40E-06	2.5E-08	1.50E+00	2E-08
Cadmium	6.88E-03	1.0	7.47E-05	5.1E-07	5.00E-04	1E-03	6.40E-06	4.4E-08	–	NA

Table G-6
Detailed Risk Calculation Tables for Adult Campers in the Drainages

CTE Scenario

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg\text{-}d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	2.94E-09	1.2E-07	3.00E-04	4E-04	3.77E-10	1.5E-08	1.50E+00	1E-08

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg\text{-}d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	2.35E-04	9.3E-07	3.00E-04	3E-03	3.02E-05	1.2E-07	1.50E+00	8E-08
Cadmium	6.88E-03	1.0	2.35E-04	1.6E-06	5.00E-04	3E-03	3.02E-05	2.1E-07	–	NA

RME Scenario

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg\text{-}d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	1.96E-08	8.0E-07	3.00E-04	3E-03	8.39E-09	3.4E-07	1.50E+00	2E-07

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg\text{-}d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	1.57E-03	6.2E-06	3.00E-04	2E-02	6.71E-04	2.7E-06	1.50E+00	2E-06
Cadmium	6.88E-03	1.0	1.57E-03	1.1E-05	5.00E-04	2E-02	6.71E-04	4.6E-06	–	NA

Table G-7
Detailed Risk Calculation Tables for Child Campers in the Drainages

CTE Scenario

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	1.25E-08	5.1E-07	3.00E-04	2E-03	3.56E-10	1.5E-08	1.50E+00	1E-08

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	2.49E-04	9.9E-07	3.00E-04	3E-03	7.12E-06	2.8E-08	1.50E+00	2E-08
Cadmium	6.88E-03	1.0	2.49E-04	1.7E-06	5.00E-04	3E-03	7.12E-06	4.9E-08	--	NA

RME Scenario

Incidental Ingestion of Sediment

			Non-Cancer Risk				Cancer Risk			
Analyte	Csed (mg/kg)	RBA (unitless)	HIFNC (kg/kg-d)	DI (mg/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (kg/kg-d)	DI (mg/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	8.17E+01	0.5	8.30E-08	3.4E-06	3.00E-04	1E-02	7.12E-09	2.9E-07	1.50E+00	2E-07

Incidental Ingestion of Surface Water

			Non-Cancer Risk				Cancer Risk			
Analyte	Cwater (mg/L)	RBA (unitless)	HIFNC (L/kg-d)	DI (L/kg-d)	Oral RfD (mg/kg-d)	HQ	HIFCancer (L/kg-d)	DI (L/kg-d)	Oral SF $(mg/kg-d)^{-1}$	Risk
Arsenic	3.98E-03	1.0	1.66E-03	6.6E-06	3.00E-04	2E-02	1.42E-04	5.7E-07	1.50E+00	4E-07
Cadmium	6.88E-03	1.0	1.66E-03	1.1E-05	5.00E-04	2E-02	1.42E-04	9.8E-07	--	NA

TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 1081025

SITE NAME: STANDARD MINE

DOCUMENT DATE: 03/19/2008

DOCUMENT NOT SCANNED

Due to one of the following reasons:

☐ PHOTOGRAPHS

☐ 3-DIMENSIONAL

☐ OVERSIZED

☑ AUDIO/VISUAL

☐ PERMANENTLY BOUND DOCUMENTS

☐ POOR LEGIBILITY

☐ OTHER

☐ NOT AVAILABLE

☐ TYPES OF DOCUMENTS NOT TO BE SCANNED
(Data Packages, Data Validation, Sampling Data, CBI, Chain of Custody)

DOCUMENT DESCRIPTION:

1 CD - BASELINE HUMAN HEALTH RISK ASSESSMENT, FINAL

Contact the Superfund Records Center to view available document.
(303) 312-6473